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LEAD AND ZINC IN UTAH, 1976

by

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Lead and Zinc in Utah, 1976

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LEAD AND ZINC IN UTAH, 1976

by L. I. Perry and Blair McCarthy

INTRODUCTION

Production and Reserves

Active lead and zinc mining operations within Utah are confined to four mines; the Burgin and Mammoth mines near Eureka, the Ontario mine near Park City and the Deer Trail mine near Marysvale in Piute County. In the last few years the state's annual production of ore has averaged 400,000 tons, the lead content has varied from 10,000 to 40,000 tons and the zinc content has varied from 12,000 to 30,000 tons. The recoverable metal content of ore produced in 1976 was 15,965 short tons of lead valued at $7,376,000 and 22,155 short tons of zinc valued at $16,395,000. Utah's all-time production of lead stands at about 5,653,000 tons and the all-time production of zinc stands at about 1,959,000 tons.

Lead-zinc mining is associated with the mining of other commodities such as silver, gold, and copper. The known lead-zinc reserves for Utah are estimated to be in excess of 2 million tons of ore. Inferred reserves, based on operator's projections and by geologic inference may total 19 million tons of ore (James, 1973, p. 48).

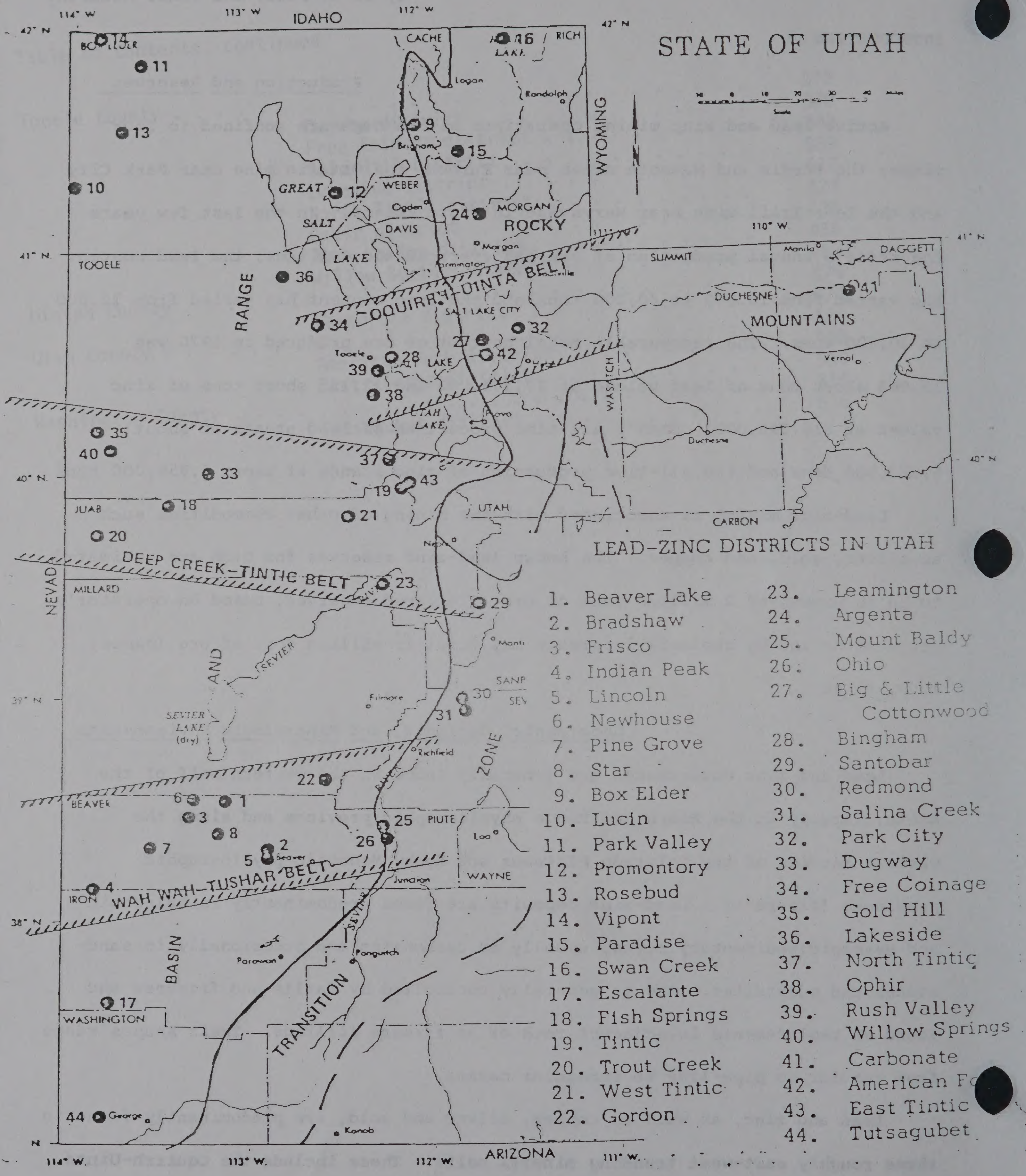
Geographic, Geologic, and Mineralogic Environments

Lead and zinc occurrences are generally found in the western half of the state, largely in the Basin and Range physiographic province and along the western margins of the Colorado Plateaus and Rocky Mountain physiographic provinces (figure 1). Lead-zinc deposits are found predominantly in Paleozoic and Mesozoic sedimentary rocks, usually in carbonates and occasionally in sandstones and quartzites. Ore is generally controlled by faults and fissures and found as replacements in adjacent rock or as fissure fillings. Their shapes range from tabular to pipe-like to irregular masses.

Lead and zinc, as well as copper, silver and gold, are predominantly found in three roughly east-west trending mineral belts. These include the Oquirrh-Uinta

Figure 1

2



LEAD-ZINC DISTRICTS IN UTAH

1. Beaver Lake
2. Bradshaw
3. Frisco
4. Indian Peak
5. Lincoln
6. Newhouse
7. Pine Grove
8. Star
9. Box Elder
10. Lucin
11. Park Valley
12. Promontory
13. Rosebud
14. Vipont
15. Paradise
16. Swan Creek
17. Escalante
18. Fish Springs
19. Tintic
20. Trout Creek
21. West Tintic
22. Gordon
23. Leamington
24. Argenta
25. Mount Baldy
26. Ohio
27. Big & Little Cottonwood
28. Bingham
29. Santobar
30. Redmond
31. Salina Creek
32. Park City
33. Dugway
34. Free Coinage
35. Gold Hill
36. Lakeside
37. North Tintic
38. Ophir
39. Rush Valley
40. Willow Springs
41. Carbonate
42. American Fo
43. East Tintic
44. Tutsagubet

belt in the north, the Deep Creek-Tintic belt in the center and the Wah Wah-Tushar belt in the south (Hilpert and Roberts, 1964, p. 29). These belts may mark areas of weakness that provided the channelways for igneous rocks and related ore-forming solutions. Mineralization is generally related to the emplacement of intrusive igneous bodies. Almost 95 percent of Utah's base and precious metals has come from the mining districts located in these mineral belts.

Method and Scope of Study

This report concerning lead and zinc in Utah is part of a study made by the Utah Geological and Mineral Survey for the U. S. Bureau of Mines. Information was gathered from more than 40 mining districts encompassing 225 mines and prospects and placed in the U. S. Bureau of Mine's "Minerals Availability System." The gathered data included information on geography, location, environment, geology, mineralogy, lithology, workings, production and reserves for individual mines. This report is prepared as part of the contract requirement.

The study was conducted from December 1975 through December 1976 and required a thorough literature search, field examination of many of the mines, and contacting owners to obtain relevant data. The study produced a compilation of all the important lead-zinc mines and districts of Utah.

HISTORY OF LEAD-ZINC MINING IN UTAH

The prospecting and mining of precious and base metals in Utah was slow to begin. The early pioneers and settlers were interested in establishing an economy based on agriculture. They searched for construction materials, coal and iron rather than precious and base metals. Expeditions were made in the 1850s in search of lead ore for bullets which was found near Minersville in Beaver County. The first lead mined in the state of Utah (then the Territory of Utah) was from the Lincoln or Rollins mine in the Lincoln district. Zinc was not sought until after 1900 because of technological problems in its milling and smelting. Serious prospecting for precious and base metals began with the arrival of Colonel P. E.

Connor and his California Volunteers of the U. S. Army in 1862. Most of his men had prospected in the California gold fields and were now encouraged to search areas in Utah. The West Jordan was the first claim to be located, September 17, 1863, in Bingham Canyon and was soon followed by many others in Bingham Canyon and surrounding areas.

Large scale lead mining did not begin until 1869 with the completion of the transcontinental railroad. It made ore shipments economical and furnished a cheap way for obtaining mining and milling equipment for the complex lead-silver ores. The development of mining continued to grow with continued expansion of the railroad. Development followed quickly and by the early 1870s Utah's major metal districts had all been organized. By 1871 at least 29 districts had been organized in the territory (Romney, 1963, p. 49). Metal mining progressed from north to south and by 1874 the Silver Reef district was organized in Washington County. In 1870 Utah produced 4,167 tons of lead, which increased to 15,000 tons in 1873 and to 25,000 tons by 1876. Between 1870 and 1880, Utah supplied 20 to 50 percent of the nation's total lead production and 10 to 15 percent of the silver production (Arrington, 1963, p. 215). Lead production continued to increase over the next 35 years. Utah's lead and zinc production is tabulated in table 1 and graphically illustrated in figure 2.

Zinc ore produced in Utah in 1904 was largely in the form of oxides suitable for electrolytic plants. Zinc was a deleterious substance for most smelter operations and penalties were assessed for its content. Zinc production in Utah began in earnest in 1925 with metallurgical advances in its mill recovery. Through 1920, lead mining showed a general rise in production, although fluctuations resulted in response to metal prices, transportation costs, mine operation problems, and labor supply. Depressed metal prices held production down in the early 1920s, but after 1923 the production of both lead and zinc began to increase dramatically. In 1925 Utah produced the most lead in its history, over 153,000 tons. The high in zinc production came in 1929 with over 51,500 tons. Utah maintained second

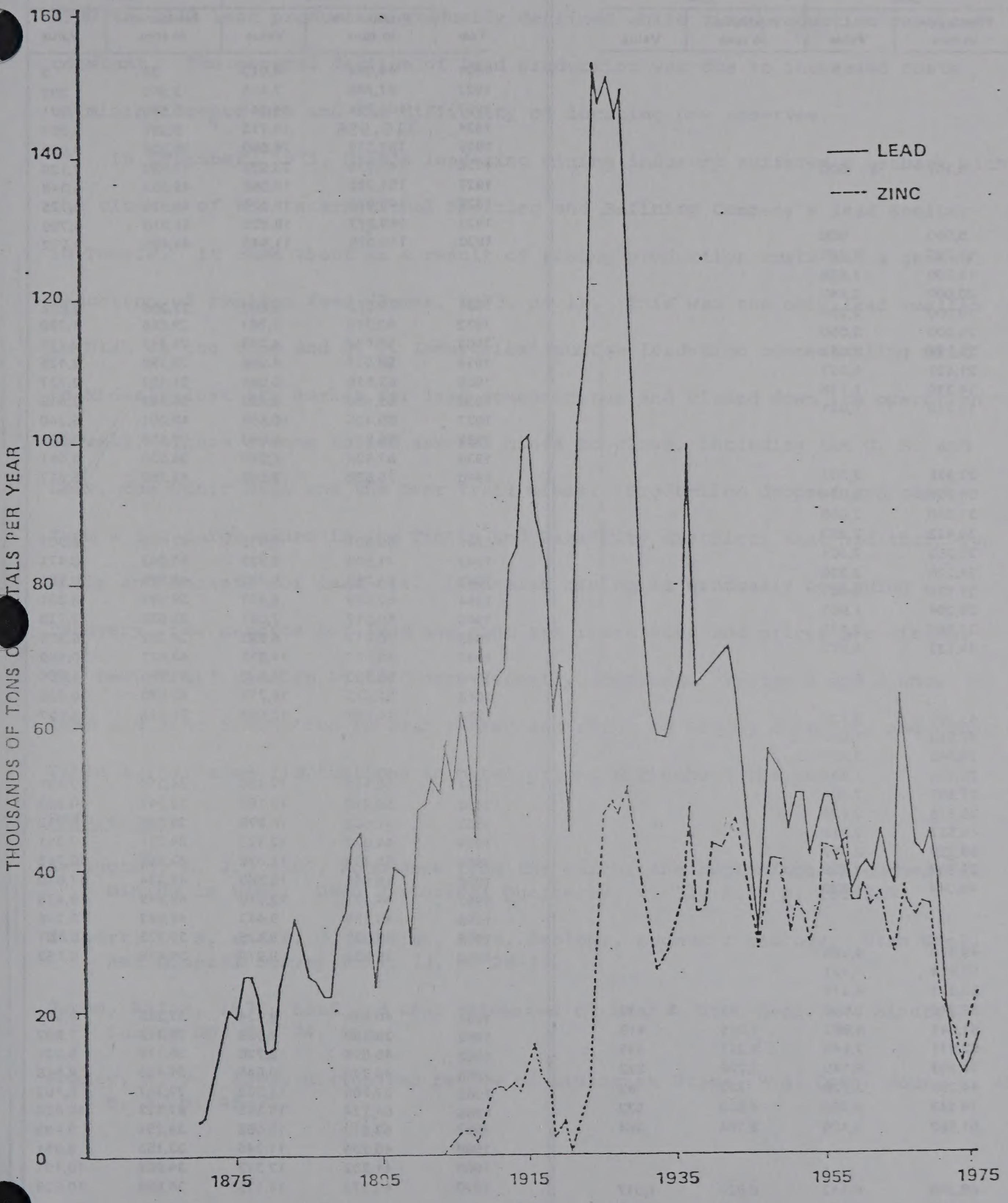


Figure 2. Lead-Zinc Past Production in Utah.

Table 1 Production of Utah's major nonferrous metals, 1865-
[values reported in thousands of dollars]

Year	Lead		Zinc	
	Production in tons	Value	Production in tons	Value
1865				
1866				
1867				
1868				
1869				
1870	4,167	$ 500		
1871	5,000	608		
1872	11,785	1,485		
1873	15,000	1,896		
1874	20,000	2,440		
1875	19,000	2,204		
1876	25,000	3,050		
1877	24,194	2,661		
1878	21,627	1,557		
1879	14,370	1,178		
1880	15,214	1,521		
1881	23,978	2,301		
1882	29,937	2,934		
1883	33,330	2,866		
1884	30,432	2,252		
1885	25,659	2,001		
1886	24,228	2,336		
1887	22,838	2,061		
1888	22,284	1,961		
1889	31,180	2,432		
1890	34,123	3,072		
1891	43,360	3,729		
1892	45,553	1,644		
1893	35,043	2,593		
1894	23,190	1,531		
1895	31,305	2,004		
1896	35,578	2,135		
1897	40,537	2,919		
1898	39,299	2,987		
1899	29,987	2,699		
1900	48,044	4,228		
1901	49,870	4,289		
1902	53,914	4,421		
1903	50,371	4,312		
1904	58,240	5,096	37	$ 17
1905	51,941	4,882	1,665	419
1906	62,671	7,145	3,237	395
1907	57,969	6,145	2,726	322
1908	44,389	3,729	730	69
1909	74,243	6,385	4,930	532
1910	61,662	5,426	8,184	884
1911	68,248	6,142	8,920	1,017
1912	70,156	6,314	8,534	1,178
1913	83,063	7,310	9,429	1,056
1914	85,662	6,682	7,995	815
1915	99,984	9,398	12,146	3,012
1916	100,745	13,903	14,786	3,963
1917	89,261	15,353	10,643	2,171
1918	83,504	11,858	9,200	1,674
1919	61,915	6,563	2,216	323
1920	70,419	11,267	4,079	661
1921	44,594	4,013	35	3
1922	67,766	7,443	2,560	292
1923	101,724	14,241	5,670	771
1924	116,956	18,713	9,281	1,207
1925	153,335	26,680	26,306	3,998
1926	147,635	23,622	47,590	7,138
1927	151,285	19,068	49,593	6,348
1928	145,915	16,926	46,929	5,725
1929	149,377	18,822	51,510	6,799
1930	115,275	11,549	44,495	4,272
1931	79,212	5,862	37,296	2,834
1932	62,776	3,767	29,666	1,780
1933	58,688	4,343	25,245	2,499
1934	58,077	4,298	28,198	2,425
1935	63,510	5,081	31,107	2,737
1936	69,886	6,430	36,192	3,619
1937	89,458	10,556	48,001	6,240
1938	65,657	6,040	33,658	3,231
1939	67,634	6,358	34,526	3,591
1940	75,688	7,569	43,788	5,517
1941	69,601	7,935	42,049	6,307
1942	71,930	9,639	45,543	8,471
1943	65,257	9,789	46,896	10,130
1944	52,519	8,403	38,994	8,891
1945	40,817	7,021	33,630	7,735
1946	30,711	6,695	28,292	6,903
1947	49,698	14,313	43,673	10,569
1948	55,950	20,030	41,490	11,036
1949	53,072	16,771	40,670	10,086
1950	44,753	12,083	31,678	8,997
1951	50,451	17,456	34,317	12,491
1952	50,210	16,168	32,947	10,938
1953	41,522	10,879	29,184	6,712
1954	44,972	12,322	34,031	7,351
1955	50,452	15,035	43,556	10,715
1956	49,555	15,560	42,374	11,610
1957	44,471	12,719	40,846	9,476
1958	40,355	9,443	44,982	9,176
1959	36,630	8,425	35,223	8,101
1960	39,398	9,219	35,476	9,153
1961	40,894	8,424	37,239	8,565
1962	38,199	7,029	34,313	7,892
1963	45,028	9,726	36,179	8,321
1964	40,249	10,545	31,428	8,548
1965	37,700	11,762	27,747	8,102
1966	64,124	19,385	37,323	10,824
1967	53,813	15,068	34,251	9,483
1968	45,205	11,945	33,153	8,951
1969	41,332	12,313	34,902	10,191
1970	45,377	14,175	34,688	10,628
1971	38,270	10,562	25,701	8,276
1972[1]	20,706	6,224	21,853	7,758
1973[1]	13,495	4,399	16,710	6,704
1974[1]	10,510	4,729	12,619	9,060
1975[1]	12,679	5,452	19,640	15,319
1976[1]	15,965	7,376	22,155	16,395

Source: USBM Minerals Yearbooks.

[1] Preliminary figures.

position in U. S. lead production and fifth in U. S. zinc production. From 1930 to 1970 lead production gradually declined while zinc production remained constant. The general decline of lead production was due to increased costs of mining deeper ore and the difficulty of locating new reserves.

In December, 1971, Utah's lead-zinc mining industry suffered a setback with the closure of the International Smelting and Refining Company's lead smelter in Tooele. It came about as a result of rising production costs and a general reduction of smelter feed (James, 1973, p. 1). This was the only lead smelter in Utah at the time and U. V. Industries' custom lead-zinc concentrating mill in Midvale lost its market for lead concentrates and closed down its operation as well. These events forced several mines to close, including the U. S. and Lark, the Ophir Hill and the Deer Trail mines. Production dropped and came from a few large mines in the Tintic and Park City districts that had their own mills and markets for lead ore. Lead-zinc mining is gradually beginning a recovery, new markets for lead and zinc are increasing and prices are rising. The Deer Trail mine in Piute County recently reopened. Tables 2 and 3 show lead and zinc production in Utah ranked according to mining districts and counties. Table 4 indicates fluctuations in metal prices throughout the years.

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Arrington, L. J., 1963, Abundance from the earth; the beginnings of commercial mining in Utah: Utah Historical Quarterly, v. 31, n.3, p. 192-219.

Hilpert, L. S. and R. J. Roberts, 1964, Geology, economic geology: Utah Geol. and Mineral Survey Bull. 73, p. 28-37.

James, Allan, 1973, Lead and zinc resources of Utah: Utah Geol. and Mineral Survey Sp. St. 44, 66p.

Romney, M. P., 1963, Historical review of mining in Utah: Min. Cong. Jour. v. 49, n. 5, p. 48-52.

Table 2: Lead and zinc production of Utah mining districts [illegible]

District	County	Lead/Pounds	Zinc/Pounds
1. Bingham	Salt Lake	4,485,279,000	1,886,091,000
2. Park City	Summit & Wasatch	2,892,885,268	1,185,927,642
3. Tintic	Juab	1,286,704,541	138,045,003
4. East Tintic	Utah	1,025,694,543	294,943,133
5. Rush Valley	Tooele	439,395,913	153,458,487
6. Frisco	Beaver	403,889,000	43,564,300
7. Ophir	Tooele	356,424,846	88,241,753
8. Big & Little Cottonwood	Salt Lake	251,811,521	24,487,428
9. Star	Beaver	56,456,100	6,937,947
10. American Fork	Utah	36,394,148	5,542,453
11. Fish Springs	Juab	17,292,796	2,800
12. North Tintic	Tooele & Utah	11,774,702+	19,515,775+
13. Mount Baldy	Piute	9,650,001	16,498,624
14. Gold Hill	Tooele	8,667,110	391,397
15. Lucin	Box Elder	5,900,000	600,000
16. Dugway	Tooele	2,908,900	2,913,700
17. Willow Springs	Tooele	2,767,492	30,200
18. Lakeside	Tooele	2,284,683	26,160
19. Promontory	Box Elder	1,818,000	6,546,000
20. Tutsagubet	Washington	949,733	22,009
21. Bradshaw	Beaver	909,572	5,603
22. Indian Peak	Beaver	328,800	547,600
23. Free Coinage	Tooele	307,524	7,500
24. Ohio	Piute	259,537	62,035
25. Lincoln	Beaver	251,881	1,196,343
26. Pine Grove	Beaver	247,022	280,500
27. Beaver Lake	Beaver	217,520	---
28. Gordon	Juab	31,600	4,700
29. Park Valley	Box Elder	13,800	---
30. Vipont	Box Elder	6,160	---
31. Leamington	Juab	4,652	---
32. Escalante	Iron	3,700	---
33. Trout Creek	Juab	2,800	29,000

Districts producing small amounts of lead and zinc, exact amounts unknown:

Argenta (Morgan), Box Elder (Box Elder), Carbonate (Uintah), Newhouse (Beaver), Paradise (Cache), Redmond (Sevier), Rosebud (Box Elder), Salina Creek (Sevier), Santobar (Sanpete), Swan Creek (Cache), West Tintic (Juab) and Silver Island (Tooele)

Table 3: Lead and zinc production by county

Lead Rank	County	Lead/Pounds	Zinc/Pounds
1.	Salt Lake	4,749,818,077	1,963,598,886
2.	Summit	1,877,208,388	618,398,413
3.	Juab	1,190,330,611	130,155,533
4.	Utah	1,132,212,583	282,114,441
5.	Wasatch	1,015,676,880	567,529,499
6.	Tooele	845,156,194	277,483,607
7.	Beaver	466,788,703	52,149,100
8.	Piute	16,599,116	16,433,414
9.	Box Elder	7,821,827	7,301,771
10.	Washington	1,389,339+	24,300
11.	Iron	704,486	547,600
12.	Morgan	683,383	600
13.	Millard	348,710	416,515
14.	Cache	30,488	17,883
15.	Uintah	19,960	5,710
16.	Sevier	16,810	108,454
17.	Sanpete	16,000+	29,000

(Several other counties have produced small amounts of lead and zinc)

Table 4. Summary of prices for five major nonferrous metals, 1881-1976

Year	Copper[1]		Lead	Zinc	Silver[1]		Gold
	D.	F.			D.	F.	
1881	18		5	5	114	114	21
1882	19		5	5	114	114	21
1883	16		4	4	111	111	21
1884	14		4	4	111	111	21
1885	11		4	4	107	107	21
1886	11		5	4	100	100	21
1887	11		5	5	98	98	21
1888	17		4	5	94	94	21
1889	14		4	5	94	94	21
1890	16		4	6	105	105	21
1891	13		4	5	99	99	21
1892	12		4	5	88	88	21
1893	11		4	4	78	78	21
1894	10		3	4	63	63	21
1895	11		3	4	65	65	21
1896	11		3	4	67	67	21
1897	11		4	4	60	60	21
1898	12		4	5	58	58	21
1899	17		4	6	60	60	21
1900	16		4	4	61	61	21
1901	16		4	4	59	59	21
1902	12		4	5	52	52	21
1903	13		4	5	54	54	21
1904	13		4	5	57	57	21
1905	16		5	6	60	60	21
1906	19		6	6	67	67	21
1907	20		5	6	65	65	21
1908	13		4	5.	53	53	21
1909	13		4	5	52	52	21
1910	13		4	5	53	53	21
1911	12		4	6	53	53	21
1912	16		4	7	61	61	21
1913	15		4	6	60	60	21
1914	14		4	5	55	55	21
1915	17		5	13	50	50	21
1916	27		7	13	66	66	21
1917	27		9	9	81	81	21
1918	25		7	8	96[2]	97	21
1919	19		6	7	100[2]	111	21
1920	17		8	8	100[2]	101	21
1921	13		5	5	100[2]	63	21
1922	13		6	6	100[2]	68	21
1923	14		7	7	82[2]	65	21
1924	13		9	6	67	67	21
1925	14		9	8	69	69	21
1926	14		8	7	62	62	21
1927	13		7	6	56	56	21
1928	15		6	6	58	58	21
1929	18		7	7	53	53	21
1930	13		6	5	38	38	21
1931	8		4	4	29	29	21
1932	6		3	3	28	28	21
1933	7	7	4	4	35[3]	35	35
1934	8	7	4	4	65	48	35[4]
1935	9	8	4	4	74	64	35
1936	9	9	5	5	78	45	35
1937	13	13	5	5	78	45	35
1938	10	10	5	5	65[3]	43	35
1939	11	11	5	5	68	39	35
1940	11	11	5	6	71[5]	35	35
1941	12	11	6	7	71[5]	35	35
1942	12[6]	12	6[7]	8[8]	71[5]	38[9]	35
1943	12[6]	12	7[7]	8[8]	71[5]	45[9]	35
1944	12[6]	12	7[7]	8[8]	71[5]	45[9]	35
1945	12[6]	12	6[7]	8[8]	72[5]	52[9]	35
1946	14[6]	15	8[7]	9[8]	79[3]	80[9]	35
1947	21	22	15	11	91	72	35
1948	22	22	18	14	91	74	35
1949	19	19	15	12	91	72	35
1950	21	22	13	14	91	74	35
1951	24[10]	26	18[10]	18[10]	91	89	35
1952	24[10]	32	16[10]	16[10]	91	85	35
1953	29[10]	31	13[10]	11[10]	91	85	35
1954	30	30	14	11	91	85	35
1955	37	39	15	12	91	89	35
1956	42	40	16	13	91	91	35
1957	30	27	15	11	91	91	35
1958	26	24	12	10	91	89	35
1959	31	29	12	11	91	91	35
1960	32	30	12	13	91	91	35
1961	30	28	11	12	91[11]	92[11]	35
1962	31	29	10	12	91	109	35
1963	31	28	11	12	103	128[12]	35
1964	32	31	14	14	103	129	35
1965	35	36	16	15	102	129[13]	35
1966	36	50	15	15	129	129	35
1967	38	47	14	14	127	155[12]	35
1968	49	50	13	14	214	214	35[14]
1969	48	62	15	15	164	179	35
1970	58	63	16	15	177	176	35
1971	48	50	14	16	154		41[15]
1972	51	49	15	16	165		40[16]
1973	59[17,18]	81	16[17]	21[17,18]	256		98
1974	77.3		22.5	36	471		159.7
1975	64.2		21.5	39	442		161.5
1976	69.7		23.1	37	435		125.3

Source: Engineering and Mining Journal, Metals Week quotations.

U. S. Bur. Mines, Minerals and Materials, a monthly survey.

[1] Copper prices = cents/pound; lead prices = cents/pound N. Y; zinc prices = cents/pound E. St. Louis; silver domestic prices = cents/troy ounce; silver foreign prices = cents/troy ounce London; gold prices = dollars/troy ounce.

Table 4: Summary of prices for five major nonferrous metals, continued

[1] D = Domestic, F = Foreign.

[2] Reflects purchases by U. S. Treasury under Pittman Act to replace silver sold to Great Britain. Act established price of silver at $1.00 per troy ounce effective 4/23/18. Actual purchases took place from May 1920 to July 1923.

[3] Purchased by U. S. Mints and Assay Offices in accordance with price set by Executive Proclamations. For summary of this series of acts see Annual Report of Director of Mines for Fiscal Year 1946.

[4] Reflects adjustment in price for domestic producers of gold to compensate for increased prices in other countries. Price finally established at $35.00 per troy ounce by Secretary of the Treasury on 1/30/34.

[5] Price set by OPA Emergency Price Control Act 1/30/42 and retroactive under Executive Order 8734 to 1940. Price controls terminated by Executive Proclamation 11/9/46.

[6] Price set at 12 cents per pound by Office of Price Administration (OPA) for copper delivered to Connecticut Valley. Price advanced to 14 3/8 cents per pound 6/3/46 until termination of OPA.

[7] Price set at 6½ cents per pound by OPA for lead delivered to New York 1/13/42. Advanced to 8¼ cents per pound 6/3/46, until termination of OPA.

[8] Price set at 8¼ cents per pound by OPA on zinc delivered to East St. Louis 1/29/42. Advanced to 9¼ cents per pound 10/14/46, until termination of OPA.

[9] Price set by OPA at 35.375 cents per troy ounce 8/10/42. Advanced to 45 cents per troy ounce 9/1/42 and to 71 cents 9/21/45. Finally advanced to 90½ cents per troy ounce 8/1/46 and decontrolled 11/1/46.

[10] Reflects government freeze on prices in response to Korean Conflict. Ceilings lifted to 19 cents per pound on lead and 19½ cents per pound on zinc 10/2/51. All ceilings removed in February 1953.

[11] On 11/28/61 the federal government ended sales at price set by Act of Congress 8/11/46.

[12] Reflects end of government policy of backing $1 and $2 bills with silver. Price advanced to $1.30 per troy ounce and maintained by the Treasury at that level until 7/17/67. At that time Treasury went to free market price and finally to highest bidder sales.

[13] On 7/28/65 a law was passed providing alloyed coinage. Half dollars were switched to a 40% Ag, 6% Cu alloy and quarter and dimes became a Cu, Ni alloy.

[14] On 3/19/68 the nation's entire stock of gold was released to back the dollar in foreign exchange. Caused a two-price gold market; countries in gold pool maintained price at $35 per troy ounce, otherwise free market gold is several dollars per ounce more.

[15] Gold prices rose throughout the year because of a variety of factors, including international monetary uncertainties, war in Southeast Asia, and balance of payments problems.

[16] Reflects President's agreement to devaluate the dollar in December 1972. Price of U. S. government gold raised to $38 per troy ounce.

[17] Zinc prices soared; copper reached 74 cents per pound in April 1973. Free market gold up to $91 per troy ounce. Dollar devaluation legislation passed with an amendment allowing U. S. citizens to own gold. In December 1973 price controls were lifted on 40 nonferrous metals including aluminum (up 16%), copper (up 13.3%), lead, platinum, tin, and zinc. Scrap metal price controls were also lifted.

[18] Zinc prices continued to climb and production dropped. Copper consumption slackened; companies imposed a reduction in number of orders accepted.

BEAVER COUNTY

Significant amounts of lead and zinc have been produced in Beaver County in the past in a mining history that extends from 1860 to 1969. Presently there are no mines producing the two commodities. These metals were produced together with gold, silver, copper, and tungsten. The produced lead amounts to almost 467 million pounds which, at the time of production, was valued at $22,153,998. Zinc production amounted to a little over 52 million pounds valued at $4,262,340. The annual rate of production of these two metals along with those of copper, gold, and silver are listed in table 5. The lead would be worth over 125 million dollars and the zinc over 19 million dollars at January, 1977 prices.

Lead and zinc districts in Beaver County that have produced are listed in order of importance: Star, Frisco, Bradshaw, Lincoln, Newhouse, Pine Grove, Indian Peak, and Beaver Lake. Star, Frisco, Bradshaw, and Pine Grove probably have the greatest potential for future production. The district locations are shown on a county outline map on figure 3.

Beaver Lake District

The Beaver Lake district is situated in the Beaver Lake Mountains which form a low circular mass of hills 11 miles (17km) northwest of Milford. The mountains are on the eastward slope of the San Francisco Mountains and west of the Beaver River. The relief is low and elevations range from 5,500 feet (1,676m) at the eastern base of the mountains to 6,900 feet (2,103m) at Lime Mountain (figure 4). The district was organized in 1887 and is principally noted for its copper production, but lead and zinc has also been produced. The Galena, or Independence Silver mine, is the only one with significant lead-zinc mineralization in the district. Apparently only lead was produced as attested by recorded production figures. As little as 56,449 pounds of lead were produced, or as much as 217,620 pounds. The breakdown of production

Table 5: Production of lead and zinc in Beaver County, 1860-1975

Year	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ounces	Silver/Ounces
1860-1875	3,700,000	---	---	765.00	257,720
1876	5,176,000	---	---	340.00	226,625
1877	6,528,000	---	---	285.00	420,000
1878	7,000,000	---	---	405.00	646,625
1879	7,910,134	---	---	425.00	756,700
1880	10,109,548	---	---	550.00	1,108,530
1881	12,570,864	---	---	425.00	1,501,341
1882	45,423,988	---	---	967.00	1,857,586
1883	30,197,000	---	10,000	580.00	1,652,980
1884	24,800,650	---	5,000	484.00	1,625,300
1885	9,800,000	---	10,000	125.00	420,000
1886	3,800,000	---	27,000	300.00	250,000
1887	3,124,000	---	65,000	300.00	235,188
1888	3,758,740	---	75,000	125.00	191,100
1889	9,129,800	---	850,000	310.00	325,330
1890	10,818,000	---	274,290	250.00	560,880
1891	15,155,760	---	863,993	110.00	677,160
1892	18,893,760	---	60,000	130.00	736,256
1893	14,261,000	---	50,000	170.00	720,144
1894	10,255,800	---	87,786	125.00	421,822
1895	14,691,600	---	10,000	712.00	700,094
1896	9,115,000	---	5,000	505.00	330,510
1897	12,180,000	---	8,194	827.00	296,824
1898	8,153,030	---	139,291	720.00	309,986
1899	4,983,453	---	918,292	1,084.00	244,939
1900	3,916,510	---	769,648	281.00	146,932
1901	6,907,969	---	932,296	1,003.00	427,382
1902	5,022,768	---	914,088	1,283.00	221,867
1903	5,565,694	---	465,369	835.00	100,214
1904	7,538,300	332,924	1,650,787	631.00	120,984
1905	4,203,156	130,220	3,555,918	1,863.00	180,912
1906	5,324,508	780,276	5,406,068	2,728.16	323,807
1907	4,458,996	1,039,144	5,639,444	2,707.45	351,147
1908	3,089,141	54,902	5,706,406	2,280.74	150,193
1909	5,766,356	656,457	1,247,235	762.92	273,977
1910	6,235,535	513,733	1,128,785	827.89	339,881
1911	4,534,678	64,927	3,739,282	2,301.10	201,259
1912	7,652,669	1,175,186	3,040,400	1,650.31	256,064
1913	10,454,583	5,522,324	3,137,234	1,117.85	344,437
1914	9,337,928	7,143,746	1,511,888	1,002.18	288,821
1915	8,589,416	2,989,811	428,916	630.23	279,694
1916	5,948,220	3,969,405	3,203,688	2,023.62	381,862
1917	5,321,400	4,133,464	3,702,085	2,192.06	297,833
1918	6,506,428	2,518,987	2,635,564	1,893.16	350,315
1919	4,897,083	44,268	538,588	1,447.23	290,109
1920	2,808,314	---	47,414	711.11	188,628
1921	1,271,131	---	28,158	251.84	80,894
1922	2,375,746	6,375	46,770	535.75	114,876
1923	3,471,858	156,372	92,850	721.46	133,428
1924	2,589,376	40,201	61,308	673.09	105,671
1925	5,024,565	167,229	270,369	1,601.84	274,549

Table 5 continued.

Year	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ounces	Silver/Ounces
1926	4,180,434	128,450	259,767	1,028.79	203,907
1927	1,186,328	97,886	53,459	325.71	46,617
1928	668,332	240,812	13,517	161.23	28,216
1929	2,118,175	1,288,591	76,477	235.30	72,060
1930	4,082,440	3,463,354	106,900	677.01	236,104
1931	1,035,168	477,719	73,942	767.88	67,542
1932	---	---	---	7.84	126
1933	3,536	---	23	2.66	254
1934	16,648	10,233	4,513	21.23	8,004
1935	205,475	178,750	9,699	212.80	20,757
1936	127,087	---	989	74.20	7,716
1937	266,712	208,400	15,967	95.00	11,382
1938	392,500	21,604	17,755	739.00	33,513
1939	1,398,213	108,750	20,683	1,546.00	89,178
1940	1,032,200	529,000	484,000	1,468.00	105,196
1941	324,000	705,000	63,600	269.00	31,455
1942	627,000	291,700	107,800	365.00	44,571
1943	279,400	726,500	118,500	238.00	37,395
1944	445,000	291,000	98,600	147.00	33,975
1945	1,396,500	899,400	438,400	454.00	85,770
1946	2,122,000	1,605,000	295,500	503.00	113,469
1947	1,637,000	2,198,000	230,600	399.00	74,758
1948	700,400	435,300	59,000	318.00	28,816
1949	302,500	60,500	52,000	215.00	11,880
1950	29,400	4,000	161,300	48.00	2,402
1951	252,400	253,200	32,500	41.00	14,692
1952	582,000	364,000	30,000	113.00	37,177
1953	2,000	---	18,000	6.00	695
1954	30,000	---	48,000	15.00	1,580
1955	---	---	34,000	10.00	1,018
1956	8,700	400	202,600	26.00	1,790
1957	89,100	47,500	203,800	51.00	12,291
1958	22,000	4,000	12,000	7.00	1,164
1959	10,000	46,000	14,000	23.00	1,832
1960	46,200[1]	218,700[1]	39,200[1]	58.00[1]	4,637[1]
1961	470,000	470,000	108,000	154.00	11,163
1962	4,400[1]	182,200[1]	165,600[1]	131.00	10,545[1]
1963	26,000	10,000	1,798,000	129.00	83,408
1964	49,600[1]	14,300[1]	6,177,600[1]	752.00[1]	178,354[1]
1965	156,000	56,000	3,722,000	509.00	157,383
1966	50,000	32,000	5,690,000	681.00	217,382
1967	33,500[1]	6,800[1]	4,664,000[1]	452.00[1]	126,241[1]
1968	53,700[1]	19,200[1]	3,602,000[1]	31.00[1]	4,306[1]
1969	24,400[1]	13,900[1]	100[1]	4.00[1]	834[1]
1970	---	---	1,429,200[1]	---	---
1971	---	---	4,936,523[1]	---	---
1972	---	---	5,904,000	---	---
1973	---	---	5,494,000	---	---
	466,788,703	52,149,100	100,447,518	58,486.64	24,960,931

[1] Stowe, C. H., 1975, Utah mineral industry statistics through 1973: Utah Geol & Mineral Survey Bull. 106

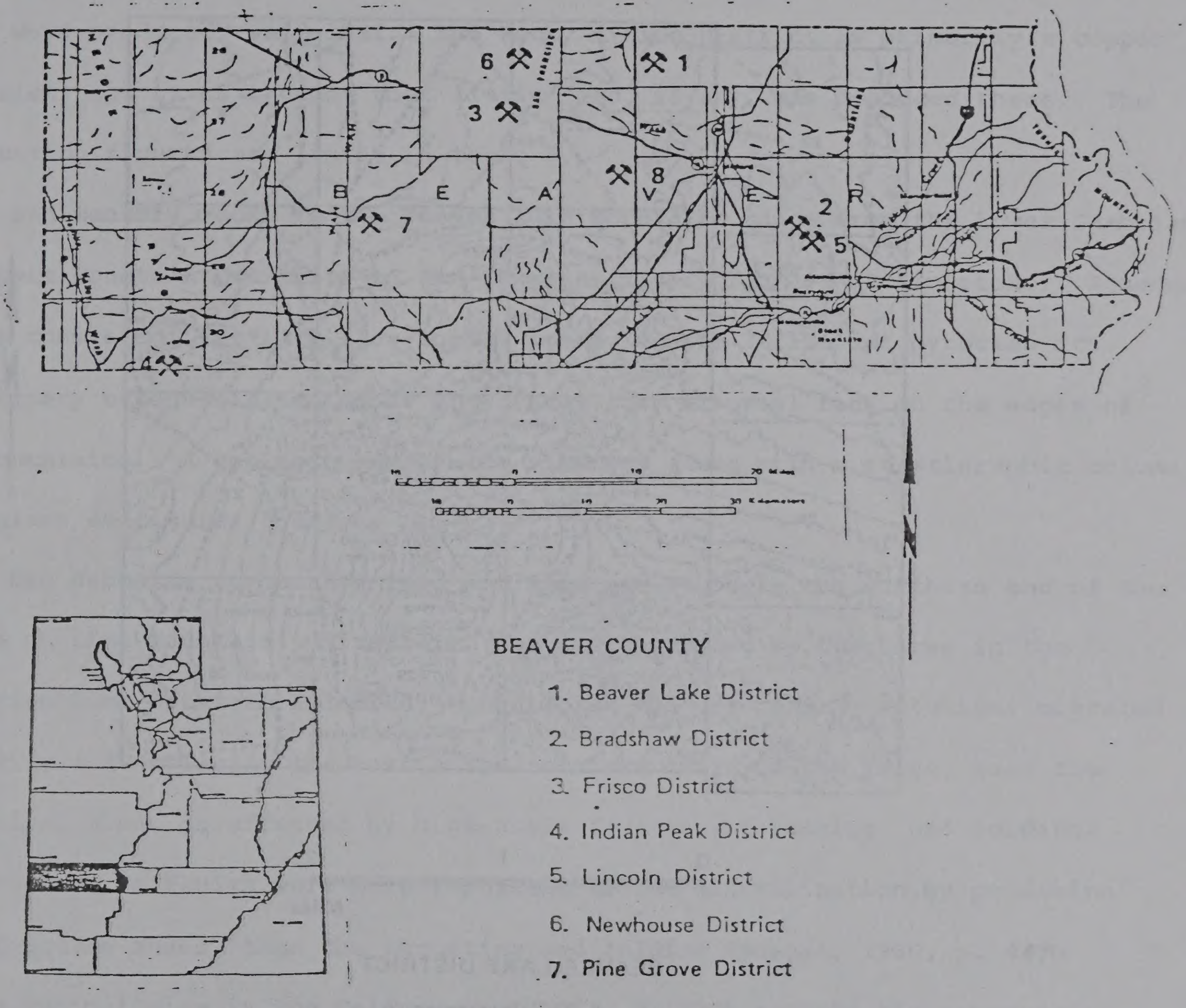


Figure 3: Mining districts of Beaver County

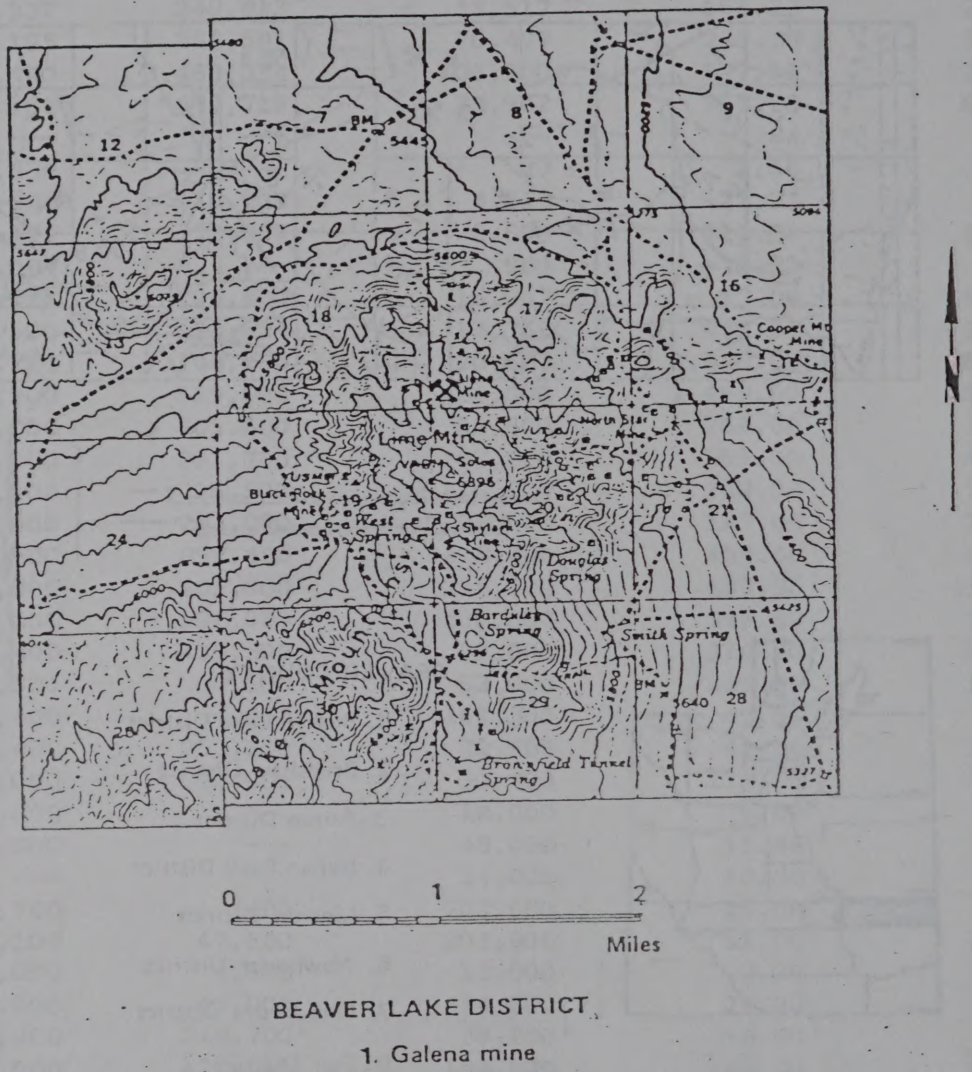


Figure 4: Topographic map of the Beaver Lake district

statistics into districts by the U. S. Bureau of Mines began in 1932. Butler (1920, p.505) shows lead produced from the combined Beaver Lake and Rocky districts amounting to more than 115 thousand pounds. No figures are available, but an optimistic estimate might indicate that an additional 45,500 pounds of lead were produced, 1918-1931. The Rocky mining district is primarily a copper district, and it is thought that little lead, if any, was produced there. The production figures are listed in table 6.

Sedimentary rocks in the Beaver Lake Mountains range from the Lower Cambrian Prospect Mountain Quartzite to the Lower Mississippian Joanna Limestone. Igneous rocks consist of Tertiary flow rocks, mostly quartz latite and pyroclastics. Quaternary unconsolidated sands and gravel form alluvial fans on the edges of the mountains. A geologic map of the district along with a stratigraphic column are given as figures 5 and 6.

Ore deposits containing lead and zinc are found in the northern end of the range on Lime Mountain. Mineralization is controlled by fractures in the Silurian Lime Mountain Dolomite, along which the ore-bearing solutions migrated, altering and replacing the host. The northern third of the range, near the principal mine, is affected by high-angle faulting, thrusting, and folding. The high-angle faults were more important to the mineralization,by producing the fracture zones, than the thrusting and folding (Barosh, 1960, p. 44). The principal mine is the Galena, Heyl(1963, p. B90) reports the presence of sizeable oxidized zinc, not confirmed in this investigation. Exploration will be necessary to prove additional ore in the district. Investigations suggest that the chances of finding sizeable ore bodies will be small.

Galena (Independence Silver) Mine

The Galena mine can be reached by driving west from Milford on Utah Highway 21 for one mile (1.6km), turning north on an improved road, and continuing northwesterly for 12.5 miles (20km). At this point a junction is reached, taking the left branch westerly another junction is reached after

Table 6: Production of lead from the Beaver Lake District, 1870-1976

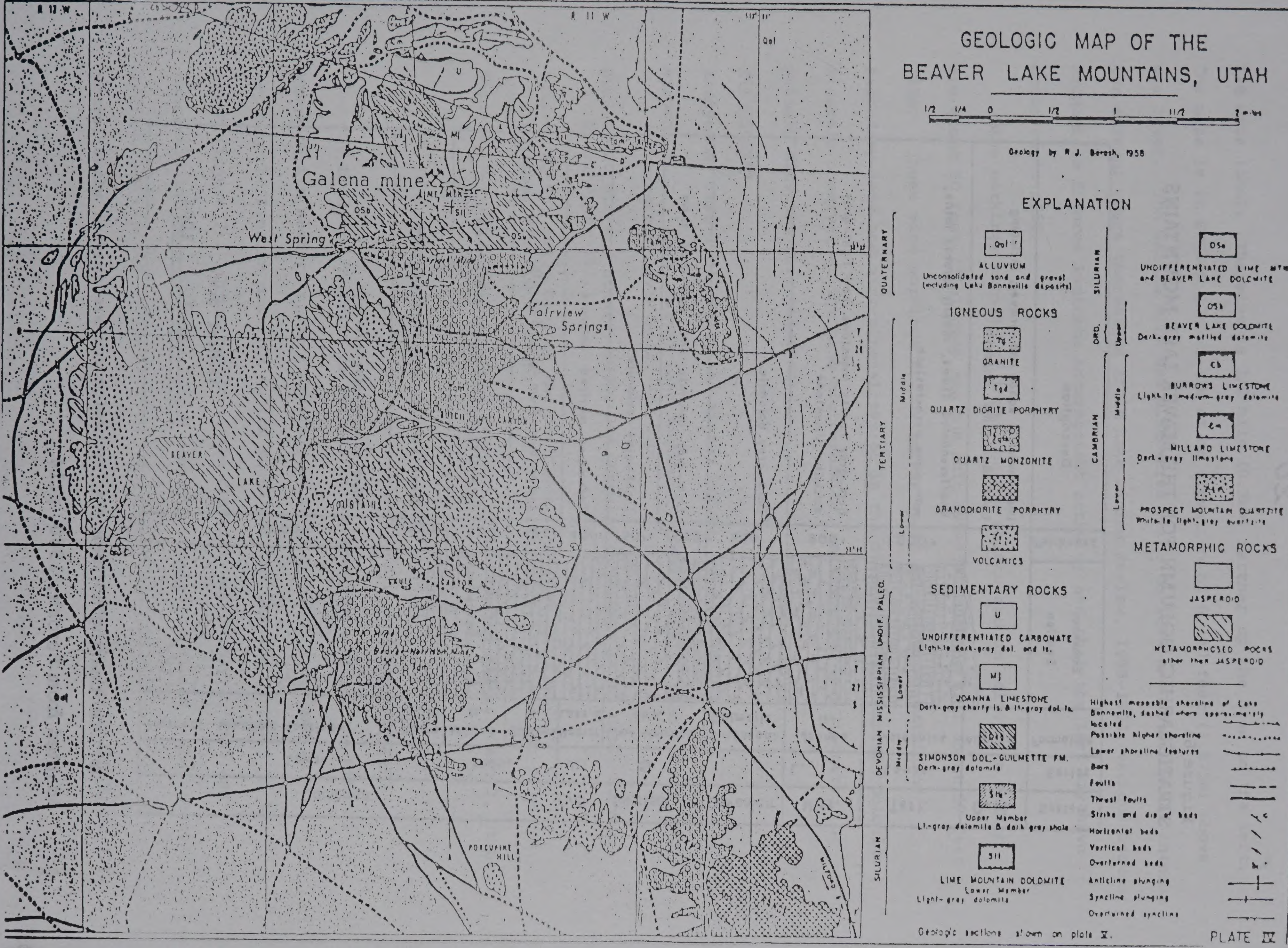
Year	Lead/Pounds	Value
1870-1902	80,000[1]	$3,530[1]
1903-1917	35,671[1]	1,715[1]
1918-1931	45,500[2]	2,045[2]
1932-1933	no production	
1934	4,378	175
1935	7,875	315
1936	no production	
1937	1,119	56
1938	no production	
1939	22,957	1,148
1940	10,420	521
1941	6,000	360
1942	1,600	96
1943-1952	no production	
1953	2,000	260
1954-1976	no production	
Totals	217,520	$10,221

[1] Figures combined with Rocky district, which may not have produced any lead--from Butler and others (1920), p. 505.

[2] Rough estimate, may be significantly lower.

Remaining figures and data from U. S. Bureau of Mines Minerals Yearbooks

GEOLOGIC MAP OF THE BEAVER LAKE MOUNTAINS, UTAH



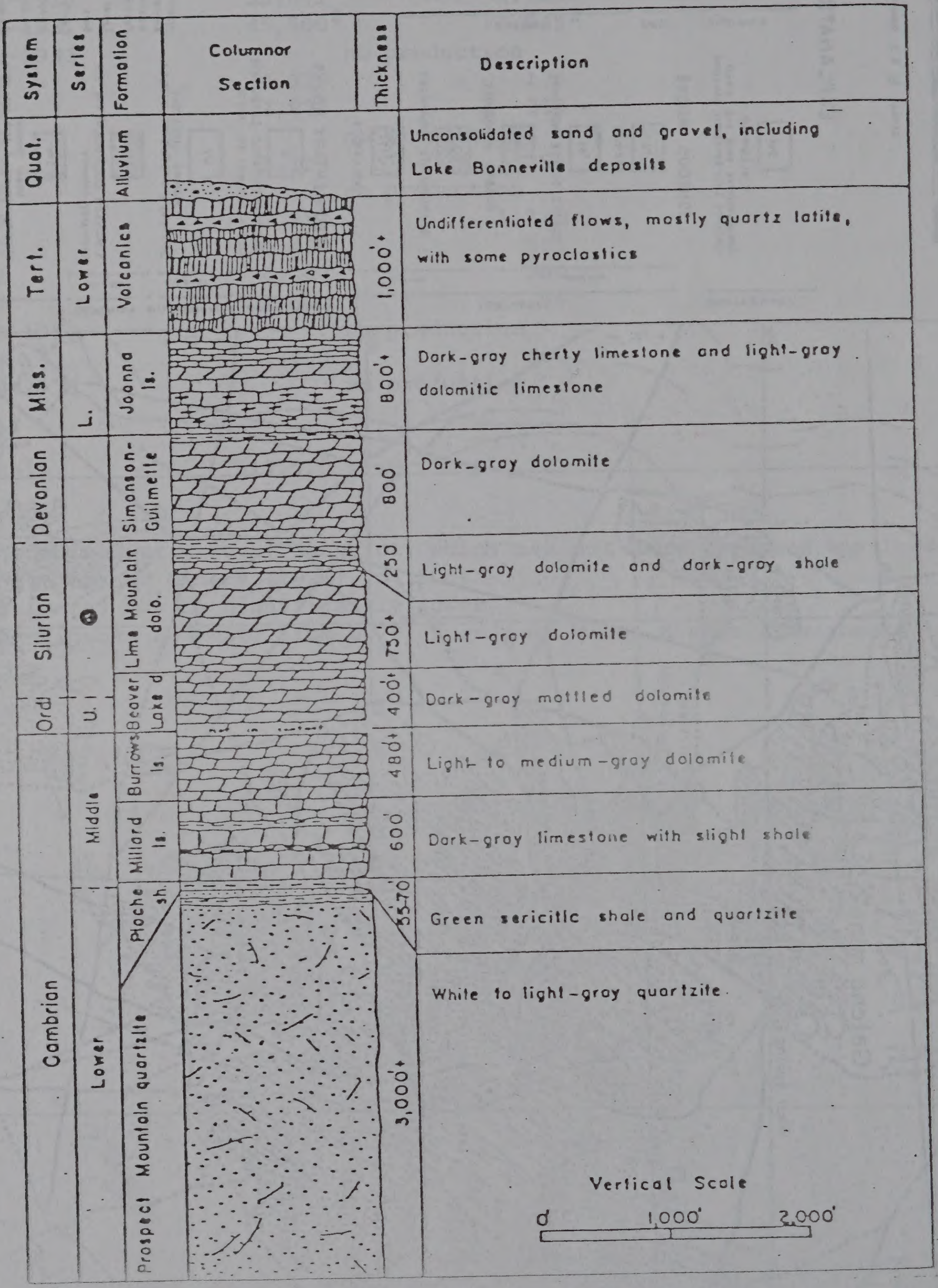
Geologic sections shown on plate V.

PLATE IV

19

Figure 6;

STRATIGRAPHIC COLUMN FOR THE BEAVER LAKE MOUNTAINS


System
Series
Formation
Columnar Section
Thickness
Description
Quat.
Alluvium
Unconsolidated sand and gravel, including Lake Bonneville deposits
Tert.
Lower
Volcanics
1,000'+
Undifferentiated flows, mostly quartz latite, with some pyroclastics
Miss.
L.
Joanna ls.
800'+
Dark-gray cherty limestone and light-gray dolomitic limestone
Devonian
Simonson-Guilmette
800'
Dark-gray dolomite
Silurian
Lime Mountain dolo.
250'
Light-gray dolomite and dark-gray shale
750'+
Light-gray dolomite
Ord.
U.
Beaver Lake d.
400'+
Dark-gray mottled dolomite
Cambrian
Middle
Burrows ls.
480'+
Light- to medium-gray dolomite
Millard ls.
600'
Dark-gray limestone with slight shale
Pioche sh.
35-70'
Green sericitic shale and quartzite
Lower
Prospect Mountain quartzite
3,000'+
White to light-gray quartzite
Vertical Scale
0
1,000'
2,000'

●: Ore-bearing horizon

Adapted from Barosh, 1960, p.14

5/8 mile (1km). The mine is 1/2 mile (0.9km) farther up the draw to the left. The mine is in SWSWSW 17-26S-11W at an elevation of 6,150 feet (1,875m) above sea level. The Galena mine was discovered prior to 1899 and activity was intense for several years thereafter (Salt Lake Mining Review, 1899-1904, various issues). Production figures indicate intermittent activity and that the last may have occurred in 1953.

Mine workings consist of three shallow shafts and an adit. The shafts are about 50 feet (15m) deep and the adit extends into the hill about 50 feet (15m). These mine workings follow narrow seams of limonite containing secondary lead and zinc mineralization in the Silurian Lime Mountain Dolomite. Minerals observed at the mine are cerussite, smithsonite, and limonite. No primary minerals were observed.

References:

Anonymous, 1899-1904, Salt Lake Mining Review, various issues.

Barosh, P. J., 1960, Beaver Lake Mountains, Beaver County, Utah: Utah Geol. and Mineral Survey Bull. 68, 95p.

Butler, B. S., and others, 1920, Ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111.

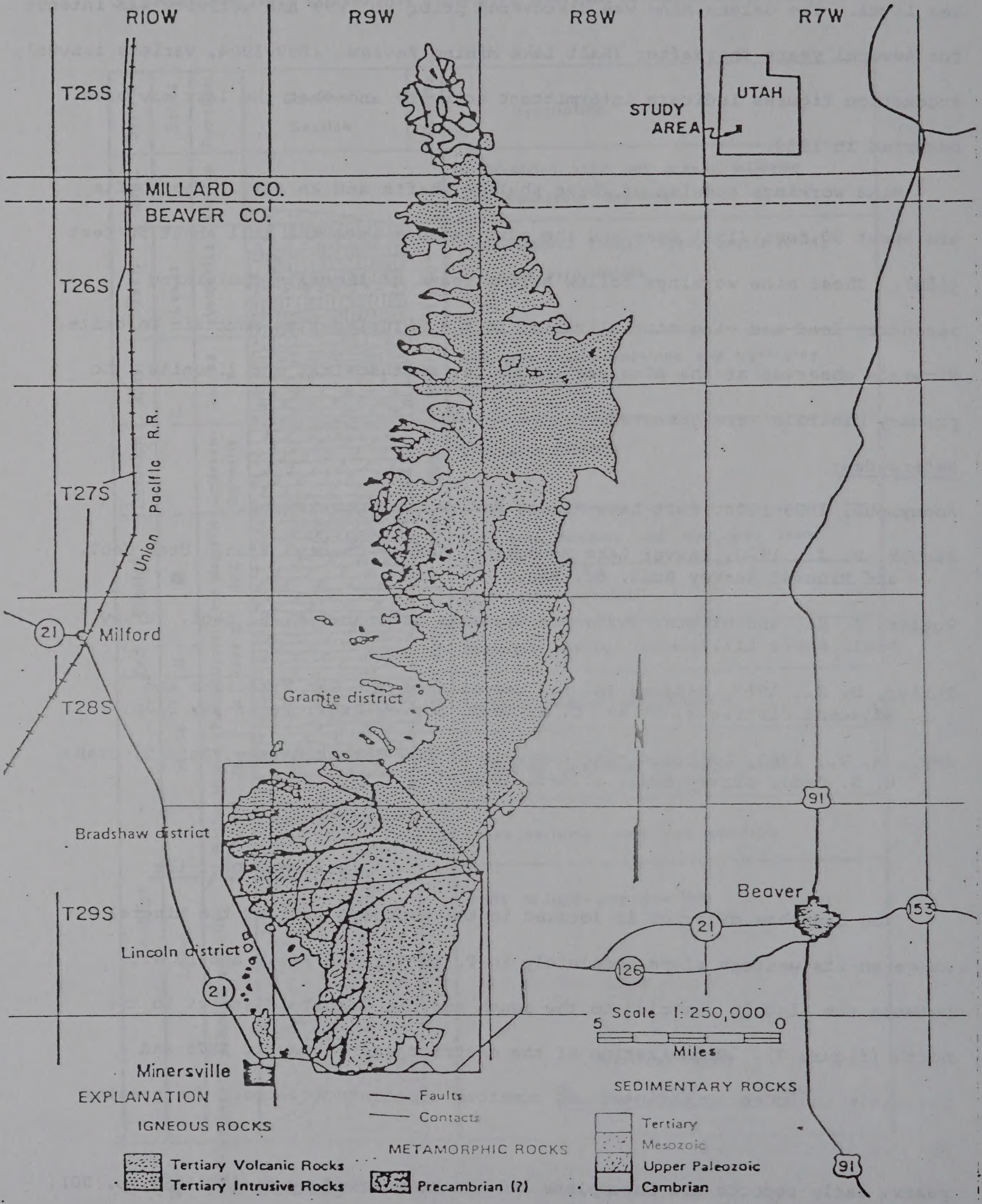
Butler, B. S., 1913, Geology and ore deposits of the San Francisco and adjacent districts, Utah: U. S. Geol. Survey Prof. Paper 80, 212p.

Heyl, A. V., 1963, Oxidized zinc deposits of the United States, Part 2, Utah: U. S. Geol. Survey Bull. 1135-B, 104p.

Bradshaw District

The Bradshaw district is located in the southern part of the Mineral Range on its western slope completely in T. 29 S., and Rs. 9 and 10 W., between the Lincoln district to the south and the Granite district to the north (figure 7). Organization of the district was on May 1, 1875 and presently includes 13 patented and numerous unpatented claims. The greater part of the production credited to the district came in the first thirty years, early records are incomplete and are summarized by Earll (1957, p. 90).

GENERALIZED GEOLOGY MAP OF THE MINERAL RANGE



Generalized geologic map of the Mineral Range, Millard and Beaver Counties, Utah (modified from Hintze, 1963).

Figure 7: Generalized geologic and location map of the Mineral Range

Adapted from Peterson, 1974, p. 46

He suggests that the recorded production figures are low and fall far short of the true amount (table 7). Recorded figures show that more than 990,000 pounds of lead, but only 5,600 pounds of zinc were produced to the present along with gold, silver, and copper. The total value of these metals at time of production exceeds $300,000. The largest producing mine of the district was the Cave mine, the production value of which was estimated at $270,000 through June 1, 1880 (Huntley, 1885, p. 475). The location of mines in the Bradshaw and Lincoln districts are shown on a map, figure 8.

The sedimentary rocks in the district range from the Mississippian Redwall Formation to an unnamed Tertiary conglomerate (figures 9 and 10). The principal ore host in the Permo-Pennsylvanian Callville-Pakoon undifferentiated unit. The sediments have been intruded by the Lincoln quartz monzonite stock. The sedimentary units in the district dip dominantly eastward and suggest a homocline, Earll (1957, p.66) believes the homocline to the west flank of a south-plunging syncline. Major faults in the district have an east-west trend and dip steeply south, the Cave Canyon fault being an example. Several unnamed northeasterly faults cut the district into a series of fault blocks.

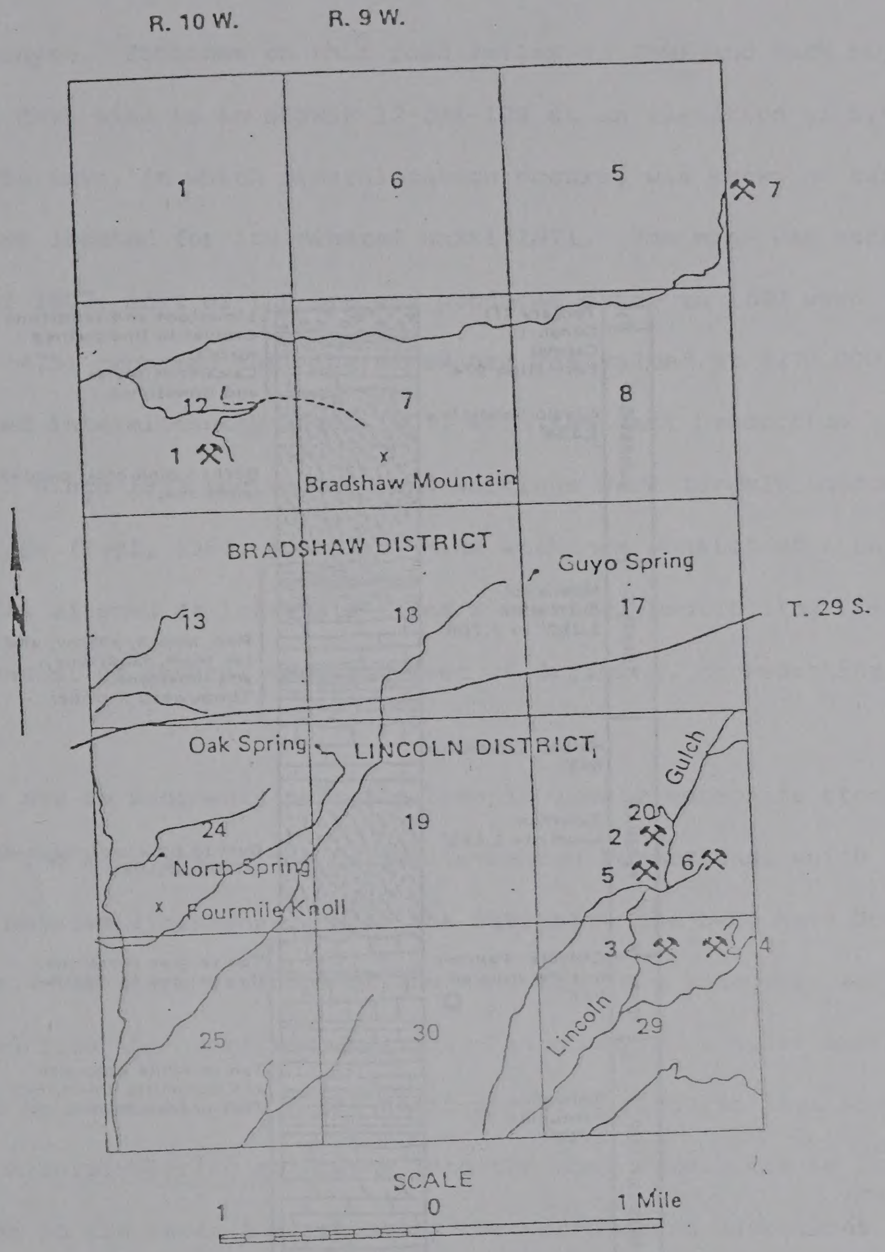
Ore deposits are associated with pre-existing caves in limestone and are cave-fill deposits and replacements in the adjacent host. Ore is found in the bottoms of caves which is commonly overlain by barren roof talus. The ore is generally of higher grade at its base and decreases in value upward. Ore is composed of limonite and cerussite containing values in gold and silver. It was the practice of the camp to ship all of the limonitic material, regardless of grade, to be used as flux in nearby smelters. Ore varied in grade, assaying as high as $800 per ton, and several hundred tons averaged 5 to 7 percent lead, $22.50 in silver, and $7.50 in gold (Huntley, 1885, p. 475).

Cave Mine

The Cave mine is reached by driving northwest from Minersville on Utah Highway 21 for 6 miles (9.6km) and then turning right on an improved dirt road

Table 7: Metals production from the Bradshaw District, 1875-1975 (Earll, 1957, p.90)

Year	Tons	Au/ozs.	Ag/ozs.	Cu/lbs.	Lead/Pounds	Zinc/Lbs.	Value
1875-1907	9,164	2,964	290,000	---	930,000	---	$288,000
1908	20	?	?	?	?	?	?
1909	1,024	79	769	3,357	37,969	---	4,994
1910	100	?	?	?	?	?	?
1911	20	?	?	?	?	?	?
1912	20	?	?	?	?	?	?
1913-1915			no production				
1916	20	?	?	?	?	?	?
1917	40	?	?	?	?	?	?
1918	20	?	?	?	?	?	?
1919-1933			no production				
1934	272	11	6,519	---	---	---	?
1935			no production				
1936	7	---	235	54	5,783	---	453
1937			no production				
1938	68	3	2,045	51	---	---	1,432
1939	91	3	2,263	---	---	---	1,641
1940	78	8	121	425	4,120	5,603	973
1941	12	3	38	---	---	---	132
1942-1947			no production				
1948	10	1	95	---	6,200	---	1,231
1949	54	1	147	---	6,500	---	1,195
1950-1975			no production				
Totals	11,020	3,073	302,232	3,887	990,572	5,603	$304,668

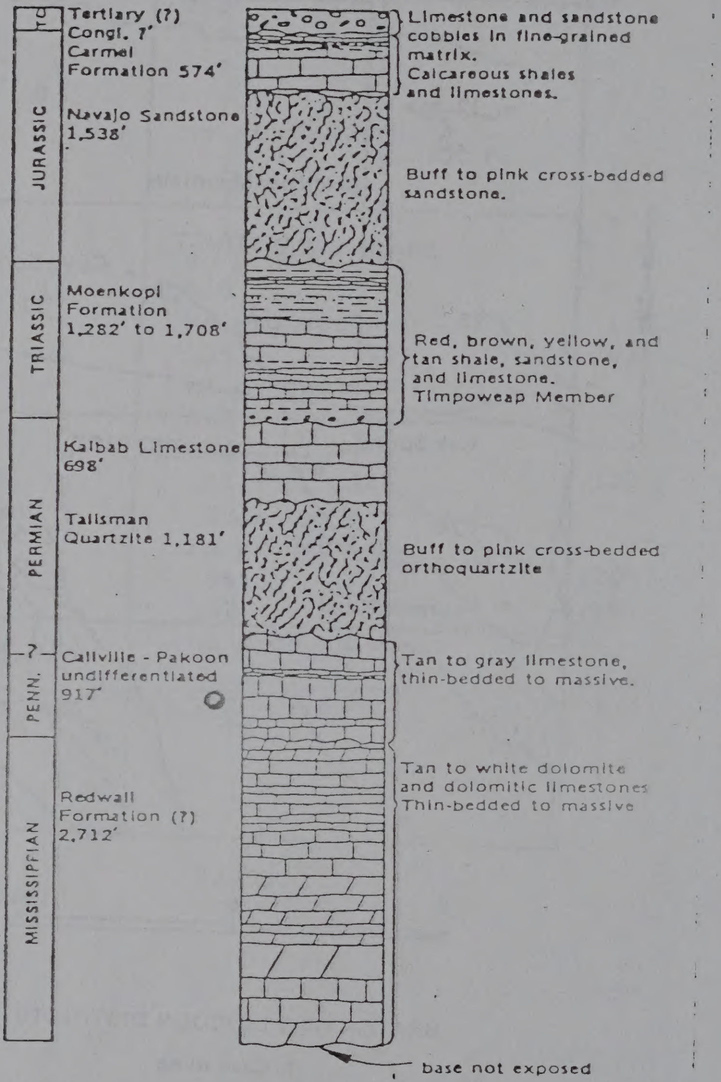


BRADSHAW & LINCOLN DISTRICTS

1. Cave mine
2. Creole mine
3. Croff mine
4. Harriet mine
5. Hecla mine
6. Lincoln mine
7. Rattler mine

Figure 8: Outline map of Bradshaw and Lincoln mining districts, Beaver County, Utah

Adapted From: USGS Cave Canyon 7½′ Quadrangle



Stratigraphic column of the southern Mineral Range.

● Ore-bearing horizon

from C.A. Petersen-Summary of Stratigraphy in Mineral Range, Beaver and Millard Counties, Utah

Figures 9 and 10: Stratigraphic column for the southern Mineral Range leading to Cave Canyon. Continue on this road 2miles (3.2km) and turn right to the mine. The Cave mine is in SENWSE 12-29S-10W at an elevation of 6,460 feet (1,969m). The cave, in which mineralization occurs, was known as early as 1859 but was not located for its mineral until 1871. The mine was worked consistently until 1907, most of the ore was produced prior to 1880 when Huntley (1885, p. 475) reported that the mined ore was valued at $270,000. The mine was worked intermittently after 1907, with the last production recorded in 1949. Since 1953 the underground workings were largely inaccessible due to caved portals (Heyl, 1963, p. B88). Mine workings consist of a series of adits and shafts aligned at intervals along a vertical controlling fissure. Total workings consist of several thousand feet of drifting, crosscutting and stoping.

The workings are in sediments near the Lincoln quartz monzonite stock. The upper workings of the mine are in the Callville-Pakoon Formations, which consist of thinbedded to massive limestones. Near the intrusive the beds have been altered to marble. The lower workings of the mine are in a Paleozoic carbonate sequence separated from the overlying Callville-Pakoon by an angular unconformity. Ore is controlled by caves aligned along north-striking fissures that have allowed the migration of mineral-bearing solutions into the host rock. Ore is found along the fissures in the caves and replacing the surrounding limestones. The cave orebodies have been described as follows:

> "The ore occurs entirely on the bottoms of caves in limestone or dolomite. Five large caves and 15 smaller ones have been found. They are all connected by seams of ocher, or by holes which serve as runways for mountain rats. Beyond the caves already known there are doubtless others, as holes and other seams lead outward. The largest cave is 120 feet long, 30 feet wide, and 20 feet high, extreme dimensions. One of average size is not over 12 feet in extent. All have an extremely irregular outline. The roofs of some are covered with a thin coating of copper carbonate and silicate. There is usually a vacant space from 1 foot to 10 feet between the roof and the ore. On the ore is usually a mass from 1 foot to 3 feet thick of blocks of limestone which have fallen from the roof. The upper portions of the deposits are generally softer, more earthy, and less valuable than the lower, where the carbonate of lead occurs. In some places the fine ocher changes into a hard massive limonite, with cavities having botryoidal and stalactitic surfaces. In

> spots, pure granular or crystallized sulphur is found, though not frequently." (Huntley, 1885, p. 474)

Minerals in the Cave mine are cerussite, anglesite, argentite, aurichalcite, chalcopyrite, cuprite, galena, gold, malachite, sphalerite, smithsonite, limonite, magnetite, pyrite, aragonite, and sulfur. Most of the mined ore has been limonitic oxide and used as a smelter flux. The old mine-workings have been stripped of most of the available rich ore, some low-grade may remain. The chances are good that undiscovered caves along the fissure zones remain to be found, some at greater depths.

Hecla Mine

The Hecla mine is located near the head of Cave Canyon on its north side in NWNWSW 4-29S-9W at an elevation of 7,920 feet (2,414m). The mine is reached by driving to the end of the Cave Canyon road and then walking the last 1/4 mile (402m) to the mine. Little is known about the mine's early history, Butler (1920, p. 535) mentions it as not in operation at the time of his visit. The mine is credited with producing most of the copper produced in the district (Earll, 1957, p. 93). Perhaps in 1907 it was the most active, the year the district reportedly produced the largest amount of copper.

The mine is developed by a shaft and two adits which have a total length of 500 feet of underground workings. These were inaccessible in the summer of 1976. The workings are in the Permo-Pennsylvanian Callville-Pakoon sequence along a breccia zone, striking northeasterly. Ore consists of fissure fillings and disseminated replacements in quartzite. Minerals consist of chalcopyrite, galena, argentite, gold, malachite, pyrite, limonite, and hematite. The ore in sight was mined and no new ore developed, leading to the abandonment of the mine. No known reserves remain.

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Lincoln District

The Lincoln mining district is in the southern end of the Mineral Range in T. 29 S., and R. 10 W., three miles (4.8km) northeast of Minersville and is accessible via an improved dirt road leading northeasterly from the town (figure 8). The Lincoln district has the honor of being first in the state of Utah to produce lead. In 1854 Isaac Grundy was sent by Brigham Young to mine lead ore at the Old Spanish mine. The name of this mine was later changed to the Rollins or Lincoln. Several tons of ore were mined and a crude smelter was built to reduce it to bullion. The bullion was hard and not too suitable for bullets (Romney, 1963, p. 48). Later it was determined that the bullion contained gold and silver giving rise to the rumor that Mormons were using silver bullets. The district was organized as the Pioneer district in 1864 and later reorganized as the Lincoln district on January 16, 1871. Recorded production for the district is 1,196,343 pounds zinc, 251,881 pounds lead, 216,885 pounds copper, 43,604 ounces of silver, and 677 ounces of gold, having a value of $346,388 at the time of production (table 8). Records for the earlier years are sketchy and the recorded production represents but a fraction of the total (Earll, 1957, p. 99). The important mines in the district are the Creole, Rattler, and Lincoln. The Lincoln was important in the earlier days of the camp, but

Table 8: Production of metals from the Lincoln District, 1871-1976

Year	Tons	Au/ozs.	Ag/ozs.	Lead/lbs.	Zinc/lbs.	Cu/lbs.	Value
1871-1907	680	225	21,580	48,000	---		$25,980
1908	20	?	?	?	?	?	?
1909-1912			no production				
1913	20	?	?	?	?	?	?
1914			no production				
1915	20	?	?	?	?	?	?
1916	4,818	?	?	?	?	?	92,650
1917	100	?	?	?	?	?	?
1918	80	?	?	?	?	?	?
1919	20	?	?	?	?	?	?
1920-1922			no production				
1923	100	?	?	?	?	?	?
1924	20	3	15	560	60	---	118
1925			no production				
1926	80	?	?	?	?	?	?
1927	20	?	?	?	?	?	?
1928-1933			no production				
1934	26	5	676	10,378	10,233	800	1,512
1935	605	73	2,720	108,750	178,750	8,747	17,458
1936			no production				
1937	552	46	2,009	80,593	187,000	2,587	20,387
1938	18	3	2,045	---	---	51	1,432
1939-1951			no production				
1952	50	7	200	2,900	---	600	1,843
1953-1954			no production				
1955	22	2	71	---	---	1,800	805
1956	72	8	235	---	---	6,500	3,255
1957			no production				
1958-1959			no data available				
1960	?	42	2,033	700	170,300	34,300	36,519
1961	?	150	8,048	---	440,100	105,200	96,946
1962	?	107	3,425	---	177,900	55,500	45,415
1963	?	2	320	---	---	---	3,366
1964			no production				
1965	?	2	44	15,400	22,500	600	6,164
1966	?	2	183	4,900	9,500	200	2,538
1967-1976			no production				
Totals:		677	43,604	251,881	1,196,343	216,885	$356,388

Sources of information:

1871-1952	Earll, 1957
1955-1958	U. S. Bureau of Mines Minerals Yearbooks
1960-1973	Stowe, 1975
1973-1976	U. S. Bureau of Mines Minerals Yearbooks

thereafter played a minor role. The Creole has been responsible for the greatest amount of production, especially in more recent years. It was still working in the early 1960s and exploration was carried out as late as 1973 (Karl Truman, oral communication). The district has been idle since that time.

Rocks in the district range in age from Permian to Tertiary. Sedimentary rocks range from Permian to Jurassic and consist of quartzites, limestones, sandstones, and shales (figures 9 and 10). These sediments have been intruded by a skarn-producing Tertiary quartz monzonite. Prominent faults in the area include the Cave Canyon fault which extends from the Bradshaw district to the north, and the Lincoln fault which branches from it and turns south. The area between these two faults is a faulted graben. The Guyo Canyon is_the_principal fault in the graben, but its displacement is much less than the bounding faults. In Guyo Canyon the intrusive is terminated by the Guyo Canyon and Lincoln faults at its southern end.

The ore of the district is related to the quartz monzonite intrusive, occurring in sympathetic shears that parallel the Lincoln fault in marbleized limestones. The ore bodies contain typical skarn minerals, and contain silver, copper, zinc, bismuth, lead, and gold values. The principal metal is copper, but the by-product lead, zinc, gold, and silver have made it economically feasible to mine it. The district contains a reserve of several hundred thousand tons of ore, mainly in the Creole and Rattler mines. Further exploration has a good chance of discovering additional mineralization.

Creole Mine

The Creole mine is located in the first gully south of Lincoln Gulch in SWNWNE 29-29S-9W at an elevation of 6,400 feet (1,951m). Prior to 1916 only small select shipments of high grade copper, gold, and silver ore were made. During World War I a copper price increase promoted the mining of 5,000 tons of ore which were shipped to the Garfield smelter. The property remained idle until World War II when 200 tons of tungsten ore averaging 0.70 percent WO_3 were mined. Mining has been conducted intermittently since then and since 1965 Karl Truman has had control of the property. Almost all of the production of the Lincoln district since 1960 has come from the Creole mine. An exploration program started in 1966 led to the discovery of additional ore at the mine, but the closing of smelters in Utah in 1971 resulted in the shelving of plans to reopen the mine.

Mine workings consist of two old shafts, an inclined adit and a long haulage tunnel. Total workings for the mine consist of 3,600 feet (1,097m) of drifting, crosscutting, and stoping (Garrick, 1966, p. 7). The host rock of mineralization in the mine is the Permian Kaibab Limestone, which strikes northeast and dips 35-50 degrees to the southeast. Ore occurs as a replacement of lower beds of the Kaibab near its contact with the quartz monzonite. Ore minerals found in the mine are chalcopyrite, bornite, covellite, azurite, malachite, copper pitch, chrysocolla, anglesite, cerussite, galena, sphalerite, smithsonite, scheelite, and bismuthinite. Gangue minerals are amethyst, calcite, clinozoisite, epidote, fluorite, garnet, hematite, magnetite, limonite, idocrase, opal, pyrite, quartz, tourmaline, tremolite, and wollastonite (Bullock, 1967, p. 15, and Garrick, 1966, p. 6). Exploration carried out in the Creole mine has blocked out ore in excess of 150,000 tons (Garrick, 1968). This ore would require beneficiation before being shipped to a smelter. The potential for finding additional ore in the area of the Creole mine is good.

Lincoln Mine

The Lincoln mine has been known as the Rollins, Old Rollins, Rawlings, and Old Spanish mine. It is on the north side of Lincoln Gulch approximately 5 miles (8km) northeast of Minersville. The shaft collar is in NWNWSE 20-29S-9W at an elevation of 6,320 feet (1,926m). The Lincoln is the oldest lead mine in the state. The first ore was refined in a crude smelter to produce bullets for the early settlers and a few tons of bullion were produced for this purpose. The mine was worked intermittently through the 1860s. In 1875 the mine was sold to the Lincoln Silver Mining Co. and a 15-ton furnace was constructed in the fall of the same year (Huntley, 1885, p. 475). The mine was mostly inactive until 1907, when it was reopened for a short time (Butler, 1920, p. 530). The mine had been abandoned for many years when Earll visited it in 1957.

Mine workings consist of two inclined shafts, one extending to the 220-foot level for ventilation and to pump water from the lower levels. The main shaft is reported to be 350 feet (107m) deep (Earll, 1957, p. 101). In the summer of 1976 the workings below the 220-foot level were flooded. The 220-foot level consists of 150 feet (46m) of drifting along the mineralization. The mine is cut in Kaibab Limestone, which has been altered to a marble by the Lincoln stock. The southern contact of the stock is marked by the Lincoln fault, the principal structural element near the mine. The ore occurs as fissure and replacement deposits in the marble near the Lincoln stock contact along sympathetic shears that parallel the Lincoln fault (Earl, 1957, p. 101). The ore strikes northeast and dips 45 degrees to the southeast. Ore minerals are galena, chalcopyrite, sphalerite, cerrusite, smithsonite, argentite, and anglesite. Gangue minerals are pyrite, limonite, hematite, and specular hematite. There are no known reserves in the Lincoln mine and in 1976 the mine owner had plans to diamond drill extensions of the mineralized zone (Karl Truman, oral communication

Rattler Mine

The Rattler mine is on the north side of Lincoln Gulch 1,700 feet (518m) southwest of the Lincoln mine in SWNESE 20-29S-9W at an elevation of 6,360 feet (1,939m). A small amount of ore has been produced from the mine, but the exact amount is not known. Little is known about the history of the mine. Mine workings consist of a shaft and two adits. Total workings amount to about 1,000 feet (305m). An adit was driven under older workings and connections made with them. The last work done in the mine was in 1970 and consisted of driving under old workings, mining and stockpiling of 1,500 tons of oxide ore on the dump. Mine workings are in the Kaibab Limestone and in the Lincoln quartz monzonite stock. The lower adit penetrates the stock and terminates in the Kaibab Limestone. The skarn ore body is in the Kaibab near its contact with the Lincoln stock. The mineralization strikes N. 20° W. and dips 60 degrees northeasterly. Minerals in the mine are sphalerite, galena, cerussite, smithsonite, plumbojarosite, malachite, chrysocolla, and hemimorphite. Gangue minerals are limonite, hematite, magnetite, calcite, quartz and pyrite. Reserves at the mine consist of 1,500 tons stockpiled on the dump and about 100 to 500 tons of ore remaining in the mine. Additional exploration would have a good chance of developing additional ore.

Croff Mine

The Croff mine is in a side canyon which branches from the south side of Lincoln Gulch and is 1,400 feet (427m) southeast of the Lincoln mine. The main shaft collar is in SWNWSE 20-29S-9W at an elevation of 6,410 feet (1,954m). The mine is not mentioned in any of the publications dealing with the Lincoln district and no production figures are available. Mine workings consist of an inclined shaft 300 feet deep (91m) dipping 60 degrees east, and three minor shafts which lie to the south aligned along a N. 5° W. mineralized trend. The mine workings have been abandoned for many years.

The workings are cut in the Kaibab Limestone and follow a select mineralized bed traceable to the south from the main shaft. Ore occurs as replacement in the limestone. Near the surface the ore has been oxidized to cerussite, plumbojarosite, smithsonite, and limonite. Sulfide ore consists of galena and sphalerite in a gangue of calcite and pyrite. There are no reserves in the mine.

Harriet Mine

The Harriet is near the top of the hill south and on the same mineralized trend as the Croff mine. The Harriet shaft is 1,200 feet (366m) east of the Creole mine and 1,900 feet (579m) south of the Croff shaft. The shaft collar is in NWNENW 29-29S-9W at an elevation of 6,660 feet (2,030m). The Harriet has made several shipments of lead ore (Butler, 1920, p. 530), but the tonnage was combined with annual figures for Beaver County. No further mention of the mine is made in the literature. Workings consist of two shafts, the southernmost is inclined 45 degrees and follows mineralization in limestone. The mine workings total about 400 feet (122m) and the property has been abandoned for several years.

Mineralization is in the Kaibab Limestone and related to the Lincoln stock encountered in the underground workings. The ore horizon ranges from 6 inches (15cm) to 3 feet (0.9m) in thickness and strikes N. 5° W. and dips 45 degrees easterly. A post-mineral fault has brought the quartz monzonite in contact with ore near the bottom of the southern shaft. The ore is oxidized and consists of cerussite, plumbojarosite, galena, limonite, and pyrite. Residual galena and pyrite are found in pockets in the ore. There are no known reserves in the mine. Exploration has been restricted to the oxidized part of the ore body and more ore might be found at greater depths along strike.

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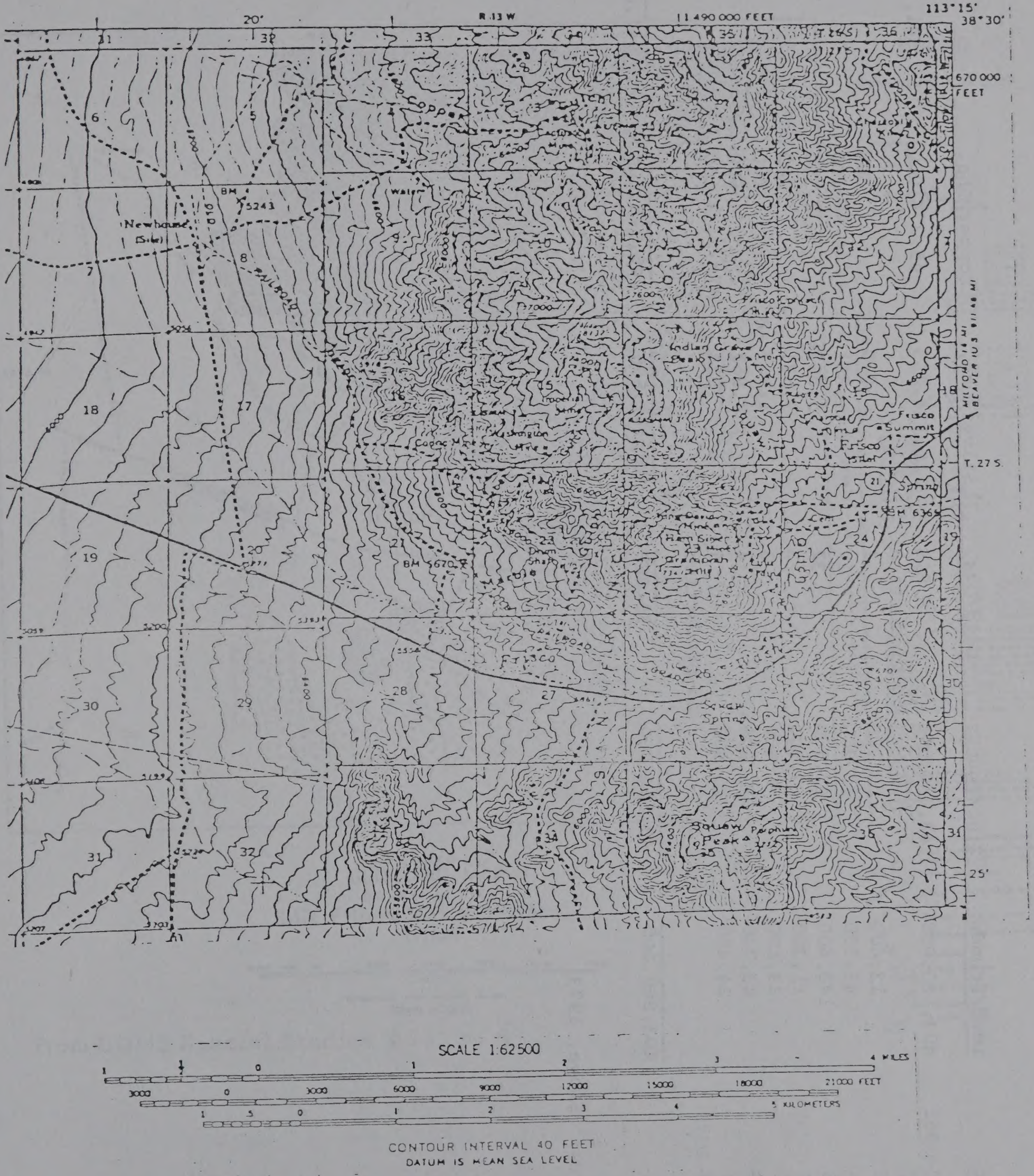
Frisco (San Francisco) District

The Frisco or San Francisco district is in the central part of Beaver County at the southern end of the San Francisco Mountains. It is 15 miles (24km) west of Milford and is reached via Utah Highway 21 (figure 11). The district has common boundaries with the Preuss (Newhouse) district on the north and the North Star district on the east. The organization of the district was on August 12, 1871 and it has been an important producer of lead, zinc, copper, silver, and gold. In its heyday it was the largest silver producing district in the state. Recorded production for the district includes 403,889,900 pounds lead, 43,564,300 pounds zinc, 45,378,600 pounds copper, 19,147,666 ounces of silver and 38,888 ounces in gold having a value of $41,679,818 (Stowe, 1975, p. 44, 50-56). Whelan and Hintze (1973, p. 92) note that the Horn Silver was the major mine in the district and approximately 60 million dollars worth of lead, zinc, silver, and copper ore were mined, mostly before 1885, indicating much more was produced than what was recorded (table 11).

Rocks in the district range in age from Cambrian to Tertiary. Sedimentary rocks range in age from Cambrian to Pennsylvanian and are limestones, dolomite, shales, and quartzite (see figures 12 and 13). Tertiary igneous rocks consist of a quartz monzonite intrusive and several flow units. On the southern end of Grampian Hill, Cambro-Ordovician rocks have been thrust over Pennsylvanian limestone. Tertiary flow rocks are faulted against Cambro-Ordovician carbonates along the Horn Silver fault on the east side of the San Francisco Mountains. The fault strikes north-south and dips steeply to the east with a displacement of over 1,600 feet (488m). The ore deposits of the district have formed along faults, such as the Horn Silver, and as replacements of limestone and volcanic rock. The ore bodies are tabular along the north-south faults and are enlarged at the intersections of east-west faults. The upper parts of the ore bodies have been oxidized and enriched, forming bonanza ore and was mined from the upper levels of the Horn Silver mine. The only remaining reserves known in the

Figure 11:

LOCATION MAP OF THE FRISCO MINING DISTRICT



Adapted from U.S.G.S. Frisco 15' quadrangle

Table 11: Production of metals from the Frisco District, 1870-1976

Year	Lead/Pounds	Zinc/Pounds	Gold/Ozs.	Silver/Ozs.	Copper/Lbs.	Value
1870-1961	403,580,000	43,472,000	38,818	19,134,253	45,374,000	$41,583,879
1962			no production			
1963	13,400	5,200	2	577	500	2,917
1964	43,200	10,200	12	1,361	700	9,521
1965	140,400	32,500	32	5,867	2,300	35,248
1966	11,300	7,300	13	3,571	200	7,923
1967	33,500	6,800	3	1,907	200	8,244
1968	43,700	16,400	4	2,867	600	14,546
1969	24,400	13,900	4	834	100	17,540
1970-1976			no production			
	403,889,000	43,564,300	38,888	19,147,666	45,378,600	$41,679,818

Source: Stowe, 1973

59

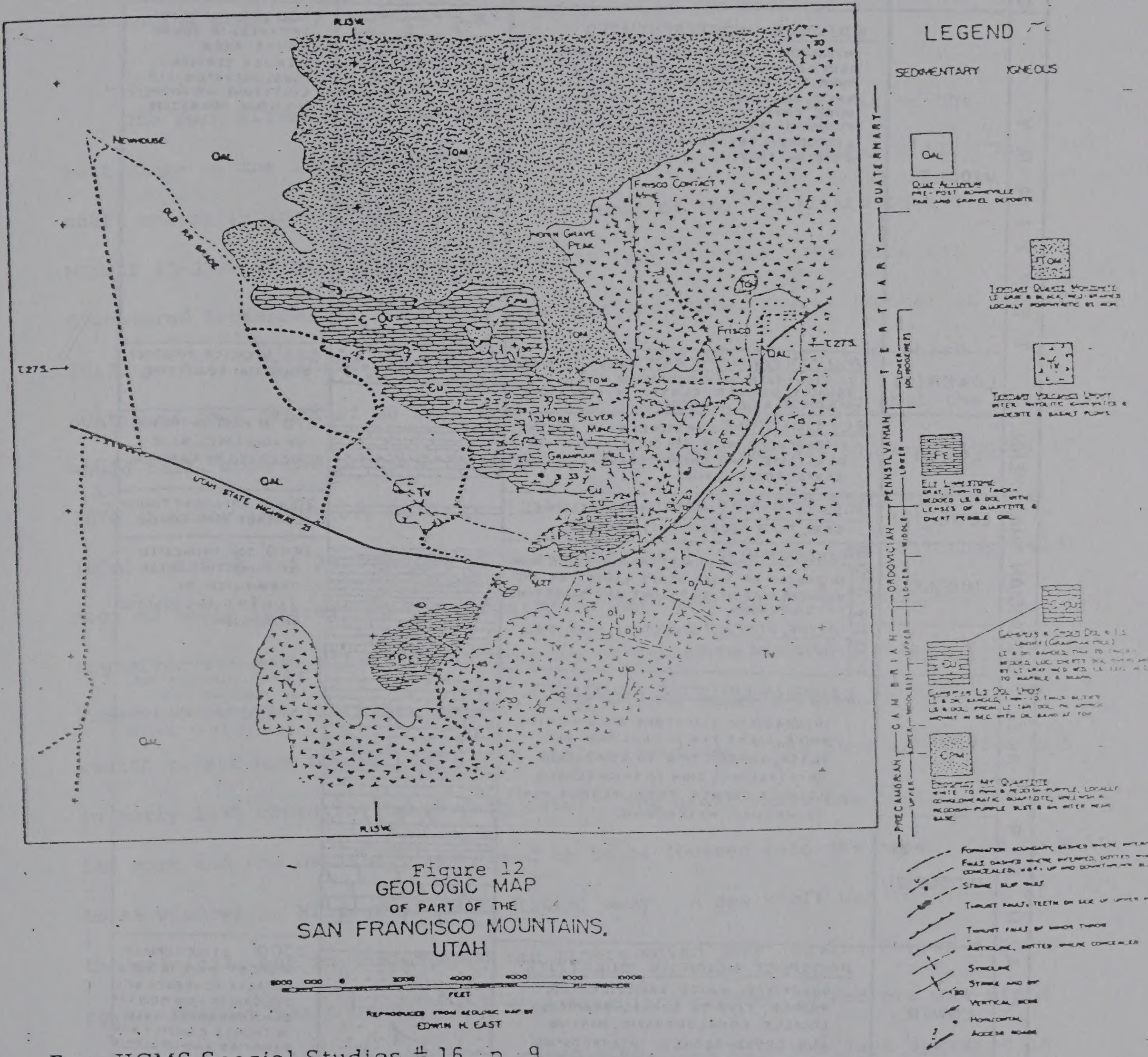
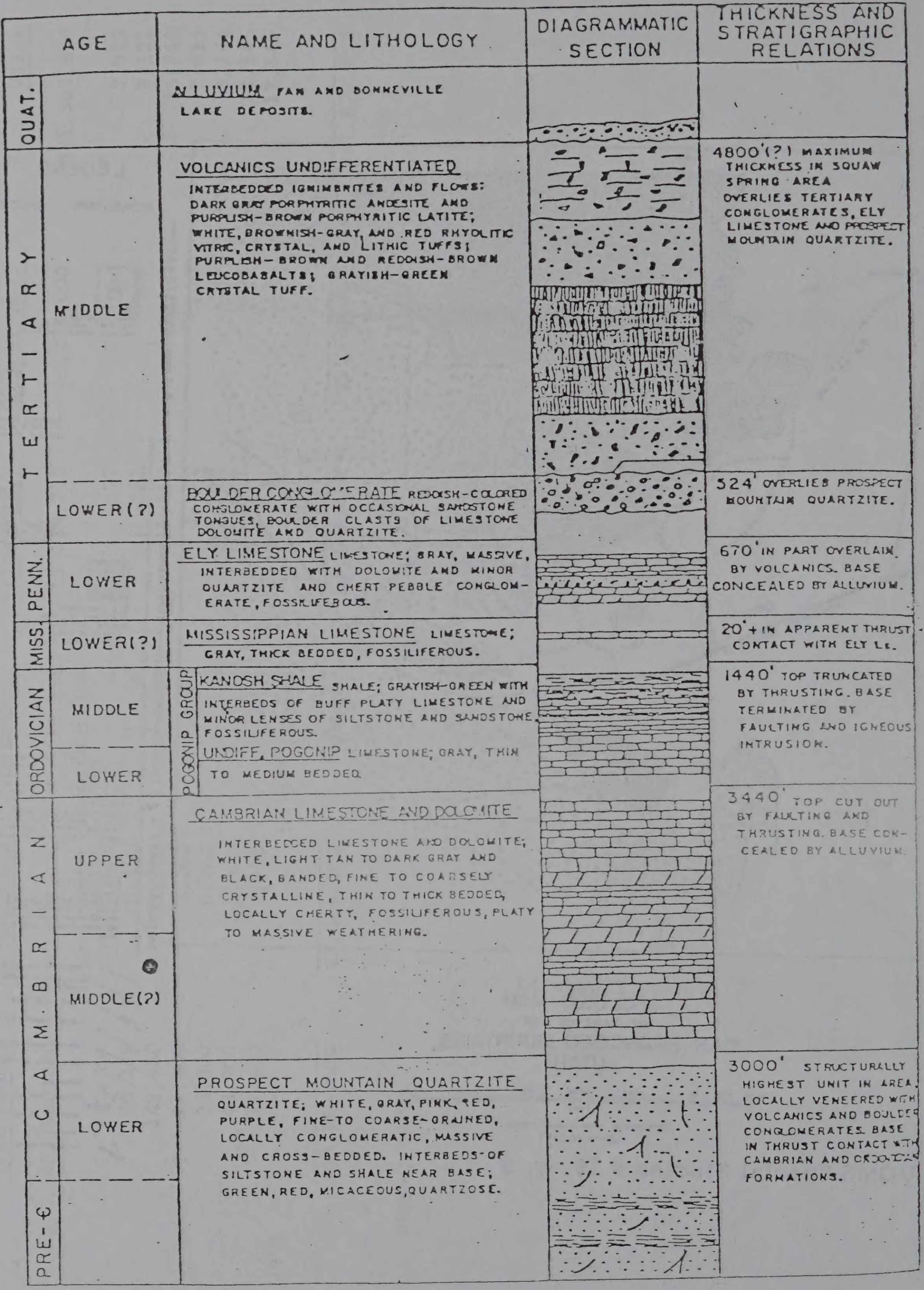


Figure 12
GEOLOGIC MAP
OF PART OF THE
SAN FRANCISCO MOUNTAINS,
UTAH

2000 1000 0 2000 4000 6000 8000 10000
FEET

REPRODUCED FROM GEOLOGIC MAP BY
EDWIN H. EAST

From UGMS Special Studies # 16, p. 9



AGE		NAME AND LITHOLOGY	DIAGRAMMATIC SECTION	THICKNESS AND STRATIGRAPHIC RELATIONS
QUAT.		ALLUVIUM FAN AND BONNEVILLE LAKE DEPOSITS.		
TERTIARY	MIDDLE	VOLCANICS UNDIFFERENTIATED INTERBEDDED IGNIMBRITES AND FLOWS: DARK GRAY PORPHYRITIC ANDESITE AND PURPLISH-BROWN PORPHYRITIC LATITE; WHITE, BROWNISH-GRAY, AND RED RHYOLITIC VITRIC, CRYSTAL, AND LITHIC TUFFS; PURPLISH-BROWN AND REDDISH-BROWN LEUCOBASALTS; GRAYISH-GREEN CRYSTAL TUFF.		4800'(?) MAXIMUM THICKNESS IN SQUAW SPRING AREA OVERLIES TERTIARY CONGLOMERATES, ELY LIMESTONE AND PROSPECT MOUNTAIN QUARTZITE.
	LOWER(?)	BOULDER CONGLOMERATE REDDISH-COLORED CONGLOMERATE WITH OCCASIONAL SANDSTONE TONGUES, BOULDER CLASTS OF LIMESTONE DOLOMITE AND QUARTZITE.		524' OVERLIES PROSPECT MOUNTAIN QUARTZITE.
PENN.	LOWER	ELY LIMESTONE LIMESTONE; GRAY, MASSIVE, INTERBEDDED WITH DOLOMITE AND MINOR QUARTZITE AND CHERT PEBBLE CONGLOMERATE, FOSSILIFEROUS.		670' IN PART OVERLAIN BY VOLCANICS. BASE CONCEALED BY ALLUVIUM.
MISS.	LOWER(?)	MISSISSIPPIAN LIMESTONE LIMESTONE; GRAY, THICK BEDDED, FOSSILIFEROUS.		20'+ IN APPARENT THRUST CONTACT WITH ELY Ls.
ORDOVICIAN	MIDDLE	POGONIP GROUP: KANOSH SHALE SHALE; GRAYISH-GREEN WITH INTERBEDS OF BUFF PLATY LIMESTONE AND MINOR LENSES OF SILTSTONE AND SANDSTONE. FOSSILIFEROUS.		1440' TOP TRUNCATED BY THRUSTING. BASE TERMINATED BY FAULTING AND IGNEOUS INTRUSION.
	LOWER	POGONIP GROUP: UNDIFF. POGONIP LIMESTONE; GRAY, THIN TO MEDIUM BEDDED.		
CAMBRIAN	UPPER	CAMBRIAN LIMESTONE AND DOLOMITE INTERBEDDED LIMESTONE AND DOLOMITE; WHITE, LIGHT TAN TO DARK GRAY AND BLACK, BANDED, FINE TO COARSELY CRYSTALLINE, THIN TO THICK BEDDED, LOCALLY CHERTY, FOSSILIFEROUS, PLATY TO MASSIVE WEATHERING.		3440' TOP CUT OUT BY FAULTING AND THRUSTING. BASE CONCEALED BY ALLUVIUM.
	● MIDDLE(?)			
	LOWER	PROSPECT MOUNTAIN QUARTZITE QUARTZITE; WHITE, GRAY, PINK, RED, PURPLE, FINE-TO COARSE-GRAINED, LOCALLY CONGLOMERATIC, MASSIVE AND CROSS-BEDDED. INTERBEDS OF SILTSTONE AND SHALE NEAR BASE; GREEN, RED, MICACEOUS, QUARTZOSE.		3000' STRUCTURALLY HIGHEST UNIT IN AREA. LOCALLY VENEERED WITH VOLCANICS AND BOULDER CONGLOMERATES. BASE IN THRUST CONTACT WITH CAMBRIAN AND ORDOVICIAN FORMATIONS.
PRE-€				

Figure 13 —Composite columnar section, San Francisco Mountains.

● Ore-bearing horizon

from Structure and stratigraphy of San Francisco mountains, western Utah by E. H. East district are in the Horn Silver mine. Zinc oxide ore was not mined in the early producing period of the district and much is reported to remain in the upper levels of the Horn Silver(Blakemore in Stringham, 1967, p. 32). Surrounding areas may contain as yet undiscovered ore bodies.

Horn Silver Mine

The Horn Silver mine, the most important of the district, is on the east slope of the San Francisco Mountains at the base of Grampian Hill. The shaft collar is about 1 mile (1.6km) southeast of the old Frisco townsite in NENWSE 23-27S-13W at an elevation of 6,550 feet (1,996m). The mine was discovered September 24, 1875 by James Ryan and Samuel Hawkes (Hooker in Butler, 1913, p. 164). A shaft was sunk encountering ore at 10 feet (3m) which continued to a depth of 30 feet (9m). The discoverers, fearing that the ore would fail, sold the property to a group of four men for $25,000 on February 17, 1876 (Huntley in Butler, 1913, p. 111). The group sank the shaft to 280 feet (85m) and took out 25,000 tons of ore averaging $100 a ton. In 1879 they sold most of their interest in the property to Jay Cooke for $5,000,000, who organized the Horn Silver Mining Company of Utah (Whelan and Hintze, 1973, p. 91). From 1880 to 1885 the mine produced heavily, the owner's feverish desire for wealth caused him to disregard good mining practices. The mine was gutted and in early 1885 caved to the seventh level. The night shift had just completed its work and the day shift was lined up to be lowered into the mine. The cave-in broke windows in Milford 15 miles (24km) away. A new shaft was sunk east of the original, but in the interim the miners moved away leaving Frisco a ghost town. The new shaft brought the mine back into production and ore was mined from deeper levels underneath the caved area. The mine was last operated in the 1960s, the work consisted of reworking the dumps and performing other surface work. Mine workings consist of a vertical shaft approximately 1,600 feet (488m) deep and several levels with several thousands of feet of drifts, crosscuts, and stopes (figures 14 and 15). The headframe is gone and the shaft is in poor

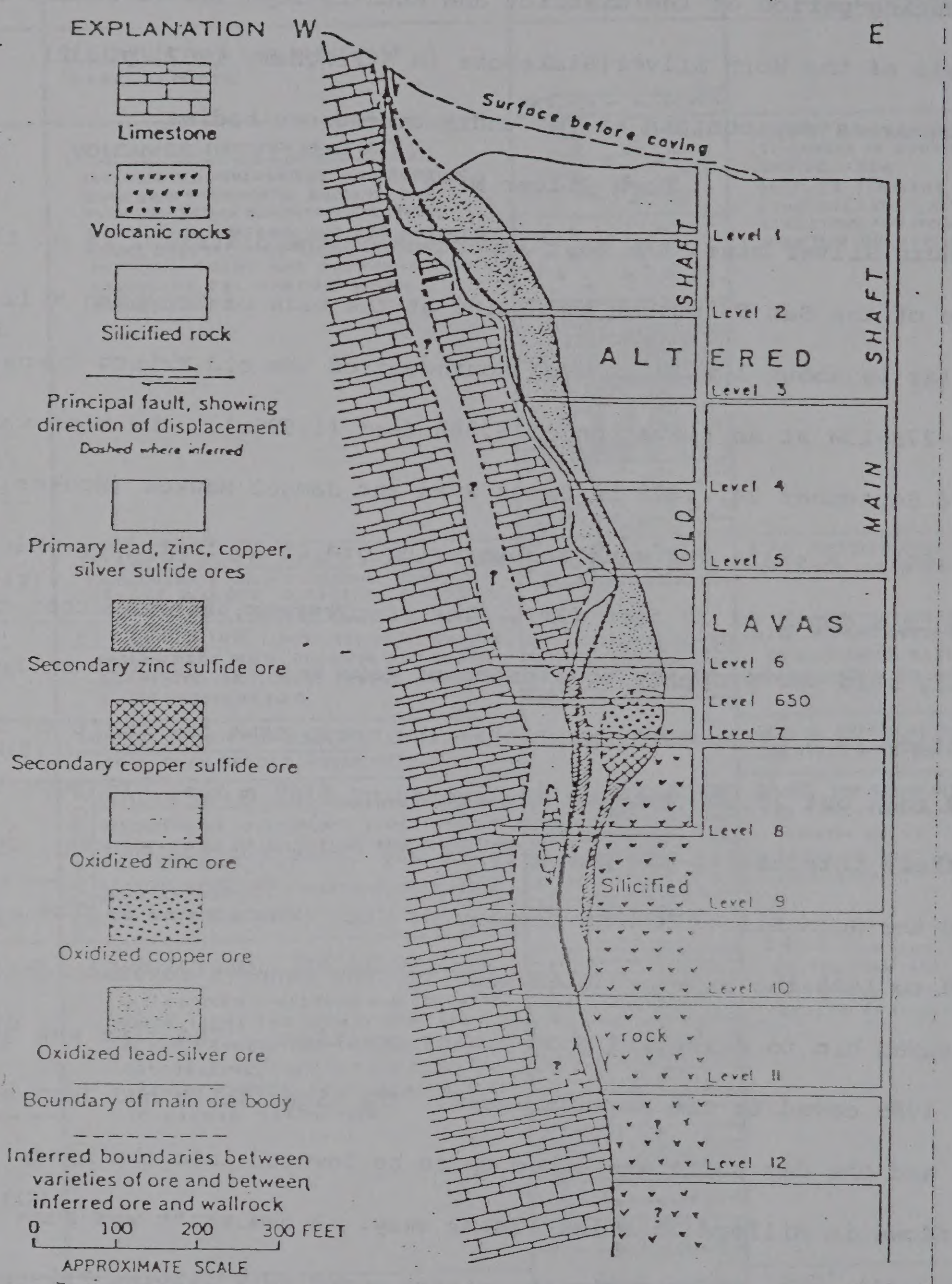


Figure 14 —Diagrammatic section of the Horn Silver ore body, Frisco, Utah, and the oxidized zinc ore bodies in the footwall limestone. Modified after Butler and others (1920, pl. 42).

from Oxidized Zinc Deposits of the United States, Part 2. Utah
by A. V. Heyl, 1963

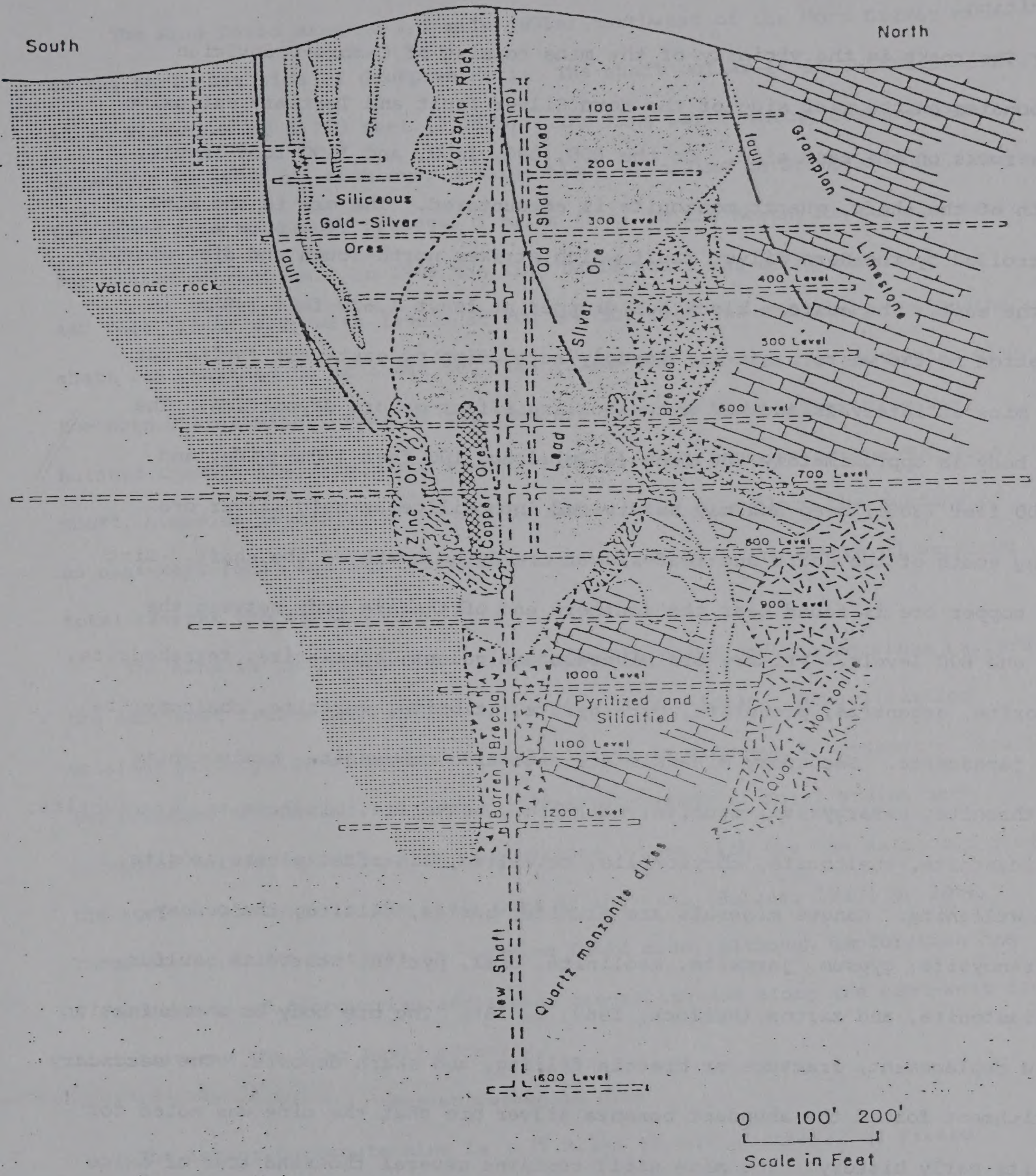


Figure 15: Generalized longitudinal section through the ore zone, Horn Silver mine.
From UGMS Special Studies #16 by Stringham, p. 31

condition.

The rocks in the vicinity of the mine consist of Cambro-Ordovician carbonates on the west side of the Horn Silver fault and Tertiary extrusive flow rocks on the east side. On the 800, 900, 1000, and 1100-foot levels, north of the shaft, quartz monzonite is encountered. The ore in the mine is controlled by the Horn Silver fault which strikes north-south and dips steeply to the east. The eastern block has dropped at least 1,600 feet (488m) in relation to the western block. Steeply north dipping east-west faults cut the mine at intervals and had a controlling effect on ore deposition. The ore body is approximately 700 feet (213m) long, 100 feet (30m) wide, and 1,000 feet (305m) deep and may be divided into siliceous gold-silver ore lying south of the shaft and lead-silver ore lying north of the shaft. Zinc and copper ore is found near the southern end of the ore body between the 600 and 800 levels. Primary ore minerals are galena, sphalerite, tetrahedrite, tenorite, argentite, proustite, pyrargyrite, stibnite, wurtzite, chalcopyrite, and jamesonite. Secondary minerals are anglesite, cerussite, hemimorphite, smithsonite, cerargyrite, azurite, malachite, beaverite, bindheimite, brochantite, chalcanthite, chalcocite, chrysocolla, covellite, linarite, plumbojarosite, and wulfenite. Gangue minerals are alunite, barite, calcite, chalcedony, dufrenoysite, gypsum, jarosite, kaolinite, opal, pyrite, scorodite, sulfur, wollastonite, and zircon (Bullock, 1967, p. 16). The ore body is a combination of a replacement, fracture or breccia filling, and skarn deposit. The secondary enrichment formed the abundant bonanza silver ore that the mine was noted for in its early history. The mine still contains several thousand tons of oxide zinc ore not mined in the early days of operation. This ore is located in the upper levels and additional work would be necessary to determine the exact tonnage and grade. Future exploration along the strike of the Horn Silver fault might discover additional ore.

King David Mine

The King David mine is 1/2 mile (805m) northwest of the Horn Silver mine on the northeast side of Grampian Hill. The shaft collar is in SWSWNE 23-27S-13W., at an elevation of 6,750 feet (2,057m). The King David Mining Company was organized in 1908 and took over a large block of claims on Grampian Hill. Water was piped from Morehouse Springs, 5 miles (8km) to the north, to furnish water for mining operations. In 1909 the King David shaft was being sunk and was 440 feet (134m) deep with levels at 200 and 300 feet (61 and 91m). Later the shaft was deepened to at least 900 feet (274m) and the workings connected with the Horn Silver mine. Some of the last ore from the Horn Silver mine was hoisted through the King David shaft. Mine workings consist of the 900-foot shaft, numerous levels from the shaft, and an adit to explore the surface of an east-west fault and its associated mineralization. The length of workings total several thousands of feet.

The mine is in Cambro-Ordovician carbonate rocks and the workings explored the east-west faults that displace the Horn Silver fault. Mineralization consists principally of pyrite in small lenses in a gangue of contact silicates and residual carbonates. A little galena is present as small grains and irregular veinlets in the altered limestone. Some rich ore was extracted from the surface workings in the early days of the camp (Butler, 1913, p. 185). There are no known reserves in the King David mine, although exploration has a good chance of discovering additional mineralization along the east-west faults that traverse the King David property.

Beaver Carbonate Mine

The Beaver Carbonate mine is 1.75 miles (2.8km) northeast of Frisco townsite at an elevation of 6,650 feet (2,027m). The shaft collar is in NWSENW 7-27S-13W. Mineralization was discovered in the Fall of 1878 and in February 1879 the property was sold for $10,000 to Campbell, Burke & Donaldson. A shaft was sunk to 212 feet (65m) and the mine was sold to the Frisco Mining and

Smelting Co. in September, 1879 for $150,000. The mine was worked until 1885, remaining inactive until 1908 when exploration was again begun (Butler, 1913, p. 178). The mine was shut down at a later date to be reopened in the 1930s for a limited amount of development work. Through 1909 the Carbonate and Rattler claims produced 6,502 tons of ore containing 2,593 tons of lead, and 553,910 ounces of silver having a value of $808,234. The Carbonate claim was first developed by an incline sunk at 45 degrees that followed ore for 60 feet. A vertical shaft was sunk from that point to a depth of 144 feet (35m) and an 80 degree incline continued to a depth of 687 feet (209m). Eight levels were developed from the shaft containing a total of 1,215 feet (370m) of drifting along the vein. A new double compartment shaft was sunk to 700 feet (213m) from which levels were cut at 250 and 350 feet (76 and 107m), containing a total of 1,235 feet (376m) of drifting (figure 16). A shaft, 700 feet deep (213m), was sunk on the Rattler claim and considerable development work was done from the shaft.

The mine is cut in the Tertiary flow rocks. The ore deposits on the Carbonate and Rattler claims are in fissures occurring along a fault striking N 85° E. and dipping steeply to the north. The veins contain argentiferous galena, sphalerite, chalcopyrite, quartz, calcite, pyrite, kaolinite, zircon, and chloride. There are no known reserves in the Beaver Carbonate mine. The veins on the Carbonate and Rattler claims have not been adequately explored and future work may discover additional ore.

Washington Mine

The Washington mine is located on the southwest side of Grampian Hill in Loeber Gulch in SWSESE 15-27S-13W at an elevation of 6,400 feet (1,951m). The mine is one of the older ones of the district. It was located along a fissure from which some high grade ore was removed from near surface workings in the early days of the camp. The amount of production is unknown. An inclined shaft was sunk to explore the mineralization at depth and considerable

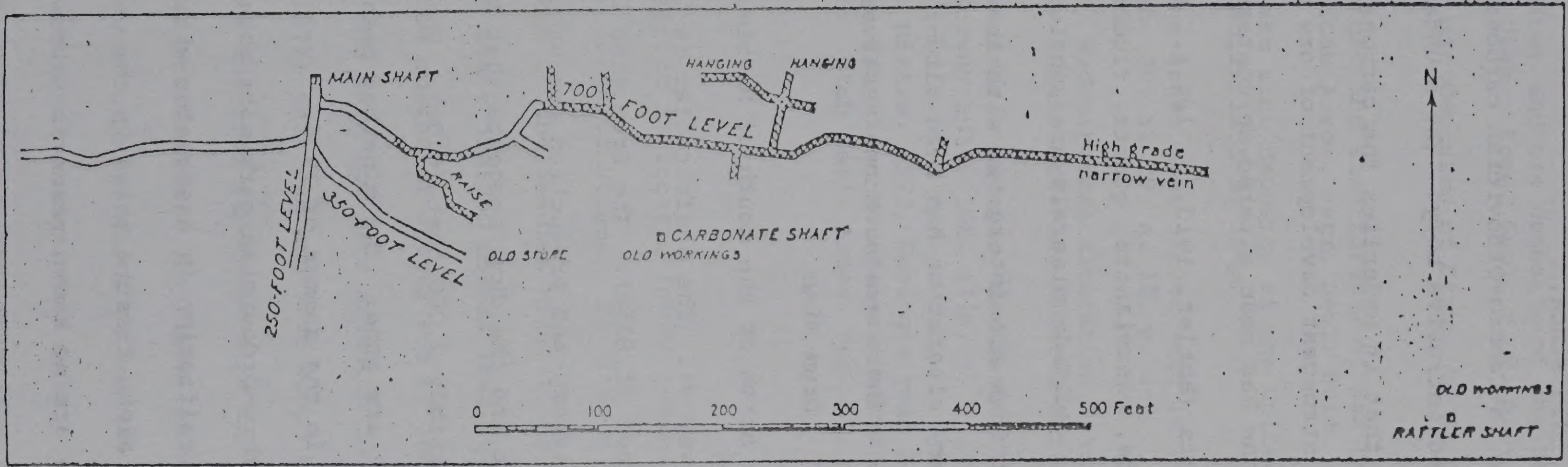


Figure 16: .—Plan of workings of Beaver Carbonate mine.

Beaver Carbonate mine from Butler, 1913, p. 179

effort was expended to locate it. By the summer of 1909 all work had ceased, and the property has been idle since.

The mine workings are in Cambro-Ordovician carbonate rocks, which have been altered by a concealed intrusive body. The abundant development of contact silicates suggest that it underlies the carbonates. Monzonite occupies fissures and the strongest development of ore minerals is near them. The entire mass of limestone has been altered to contact minerals, and sulfides are present in small amounts (Butler, 1913, p. 184.). Contact minerals include tremolite, garnet, diopside, vesuvianite, quartz, fluorite, chlorite, and recrystallized carbonates. Sulfide minerals are sphalerite, galena, pyrite and chalcopyrite. The sulfides are intergrown with the contact silicates and are contemporary. Secondary alteration has been slight and extends a short distance below the outcrop. There are no known reserves in the Washington mine.

Drum Mine

The Drum mine is just north of the mouth of Marble Gulch and is 1.5 miles (2.4km) north of Utah Highway 21. The shaft collar is in SWNWSE 22-27S-13W., at an elevation of 6,020 feet (1,835m). The Drum mine is not mentioned in the literature and its early history and production are unknown. The workings consist of a vertical shaft and the dump suggests that the total length of workings are extensive, possibly 2,000 feet (610m). The headframe is intact but other surface buildings are gone. The mine had been abandoned for many years at the time of visit in the summer of 1976.

The mine is cut in Cambro-Ordovician carbonate rocks and material on the dump suggests that the mineralization is associated with a contact-type deposit. Mineralization is probably along fissure zones in the carbonates and consists of lead-zinc-copper. There are no known reserves in the mine.

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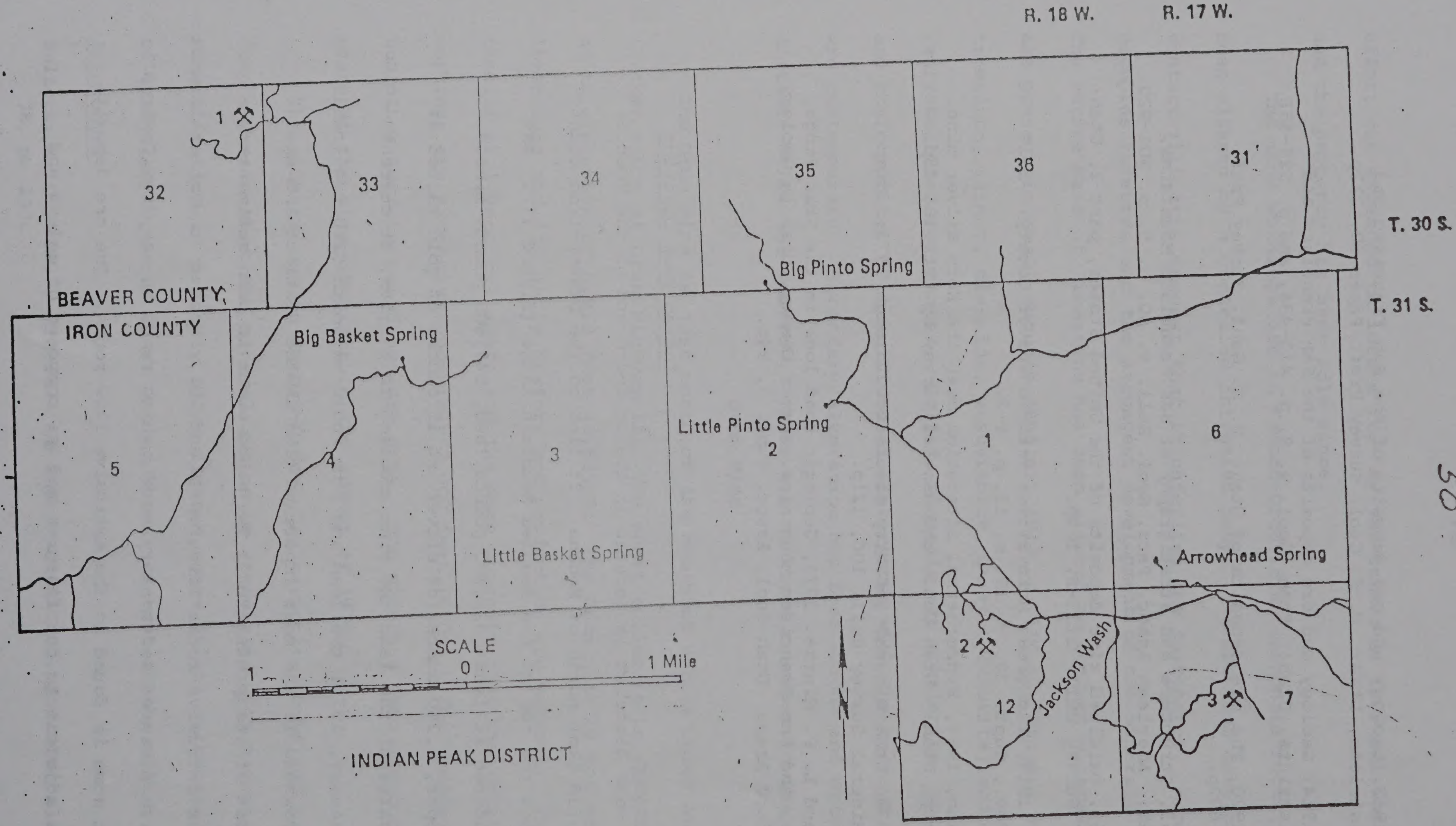
Indian Peak District

The Indian Peak district is located in the southern end of the Needles Range, 24 miles (38.6km) north of Modena. It lies on the Beaver-Iron county line and straddles the top of the Needles Mountain Range (figure 17). The district has produced at least 328,800 pounds lead, 547,600 pounds zinc, 7,700 pounds copper, 1,260 ounces of silver and 12 ounces of gold valued at $108,407. The value of the lead and zinc amounted to $75,589, at current metal prices (January, 1977) the lead and zinc would be worth $290,944 (table 10).

The New Arrowhead is the most important mine in the district and has accounted for most of its production. The mines occur in both sedimentary units and igneous extrusive rocks (figures 18 and 19). Most of the mineralization is associated with fissured sedimentary rocks, which range in age from Cambrian to Tertiary, but some is found in the extrusive flow rocks. The ore deposits are replacements adjacent to the fissures and are composed of galena and



1. Calumet mine
2. New Arrowhead mine
3. Skougard mine

Adapted From: USGS Atchison Creek 7½' Quadrangle
USGS Pinto Spring 7½' Quadrangle
USGS Steamboat Mtn. 7½' Quadrangle

Figure 17: Outline map of the Indian Peak mining district

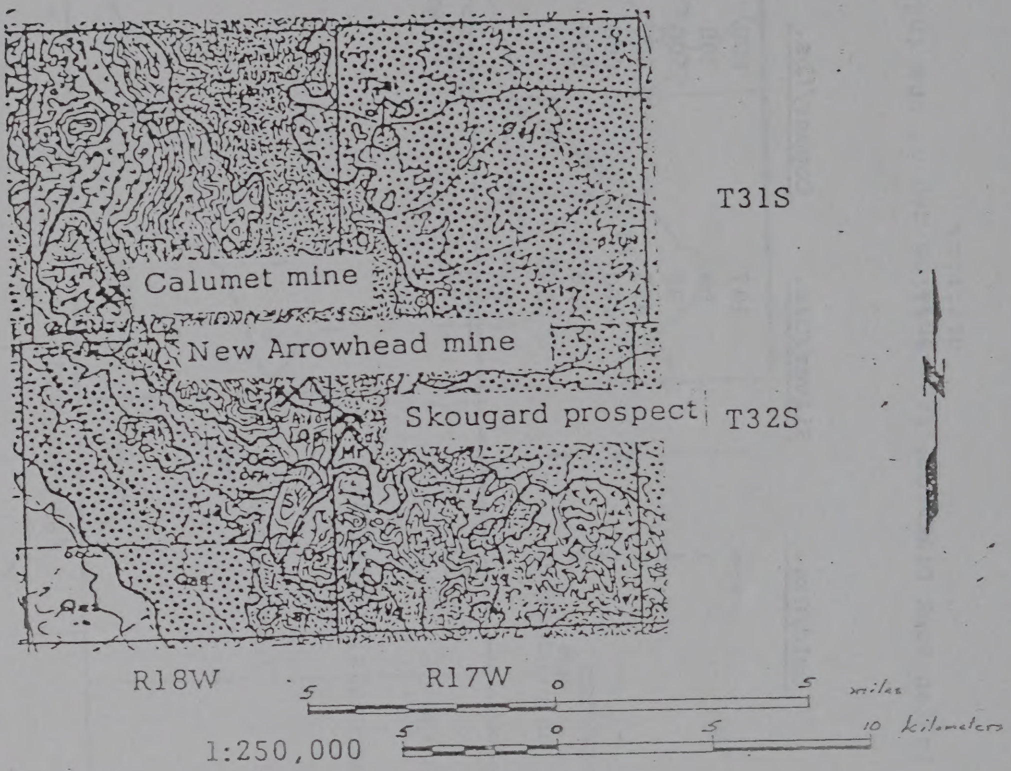
Table 12: Production of metals from the Indian Peak District, 1941-1976

Year	Lead/Pounds	Zinc/Pounds	Gold/Ozs.	Silver/Ozs.	Copper/Lbs.	Value
1941	55,700	---	---	197	800	$3,409
1942	25,300	---	1	90	300	1,330
1943	50,400	126,500	1	90	500	17,606
1944	121,900	205,000	6	495	3,600	34,410
1945	31,500	158,600	2	180	2,000	21,416
1946	44,000	57,500	2	208	500	12,130
1947-1976			no production			
Totals	328,800	547,600	12	1,260	7,700	$108,407

Source: U. S. Bureau of Mines Mineral Yearbooks, 1941-1946

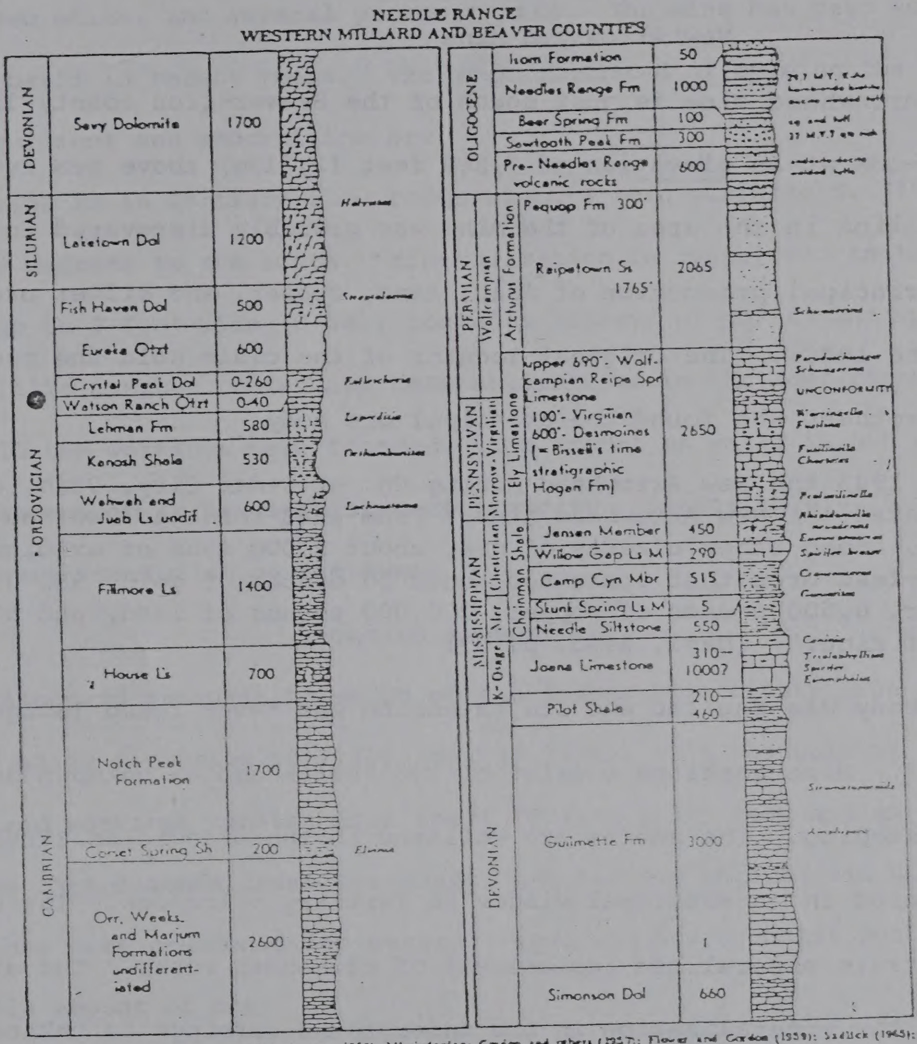
Figure 18:

GEOLOGIC MAP OF INDIAN PEAK DISTRICT



Qas-Alluvial surfaces
Qag-Colluvium & alluvium
Tvq -
T_2rt- } Tertiary volcanics
T_1ai-
Tip-Tertiary intrusive
Mr-Redwall limestone
Ds-Sevy dolomite
Sl-Laketown dolomite
Ofh-Fish Haven dolomite
Oes-Eureka & Swan Peak quartzite
Op-Pogonip formation

Adapted from Geologic map of southwestern Utah 1:250,000



After: Gould (1959); Hintze, unpublished notes (1959); Mississippian: Gordon and others (1957); Flower and Gordon (1959); Sadlick (1965); Permian: Bissell (1962b); Baroch (1964); Oligocene volcanics: Mackin (1960),(1963); Armstrong (1963),(1970a); Conrad (1969); Chainman-Ely conodonts: Dunn (1970)

Adapted from Geologic History of Utah by Lehi F. Hintze p. 144

● Ore-bearing horizon unknown carbonate rock underlying the Eureka Quartzite

Figure 19: Stratigraphic columns for areas of western Beaver County, notably for the Indian Peak mining district.

sphalerite containing minor amounts of copper and silver. The district has not been extensively explored and future effort might discover additional and sufficient mineralization to warrant further development.

New Arrowhead Mine

The New Arrowhead mine is just south of the Beaver-Iron county line in SENENW 12-31S-18W at an elevation of 7,580 feet (2,310m) above sea level. The mineralization in the area of the mine was probably discovered in the late 1800s. The principal production of lead, zinc, copper, and silver ore occurred in the 1940s. The original locator of the claim sold the property to the Fife Brothers who found the principal ore body.

> "In 1943 the New Arrowhead Mining Co. of Cedar City, Utah, opened and operated the New Arrowhead mine. From 1943 through 1946 the company produced, among other classes of ore, about 2,000 tons of oxidized zinc and zinc-lead ores that contained about 10 ounces of gold, 950 ounces of silver, 6,500 pounds of copper, 270,000 pounds of lead, and 570,000 pounds of zinc." (Heyl, 1963, p. 97)

The ore body was faulted and its extension was never found (Burgess, oral communication). Mine workings consist of two shafts and an unknown amount of drifting and stoping. The shafts are collared in the Ordovician Eureka Quartzite exposed in an erosional window in Tertiary volcanics. The underground workings penetrate mineralized replacement of carbonate rocks. The attitude and nature of the mineralization in the underground workings is unknown. A sample of ore from the loading chute assayed 15 percent lead, 3.75 percent zinc, 0.195 percent copper, 0.009 ounces gold and 0.335 ounces silver. This ore contains mainly galena and sphalerite in a gangue of quartz. It is not known whether reserves remain in the mine. The unfound faulted part of the ore body remains a target of future exploration.

Calmet Mine

The Calmet mine has been known as the Higgins and/or Hist mine. It is located in SENENE 32-30S-18W at an elevation of 7,705 feet (2,348m) above sea level. Mineralization in the area of the mine was probably discovered in the late 1800s. Butler (1920, p. 529) reports that the area had been active for several years prior to his work. The mine has produced a small amount of lead-zinc-silver ore, but no figures are available. Mine workings consist of a shaft, two adits, and several prospect pits. The mine has been worked on a limited basis in recent years. The work consisted of opening the vein with surface equipment and stockpiling ore.

The mine is in Tertiary flow rocks along a vein striking N. 77° E. and dipping 75 degrees to the south. Mineralization is restricted to the fissue, which is up to 2 feet wide (0.6m), contains kidneys of galena and sphalerite in an argillic gangue. Water has been encountered in the most recent work and in 1976 the workings were flooded. The amount of water is not excessive and is pure enough to be used for camp purposes. Approximately 15 tons of ore have been stockpiled on the dump.

Skougard Prospect

The Skougard prospect is south of the Beaver-Iron county line in SWSWSE 7-31S-17W at an elevation of 7,360 feet (2,243m). The Skougard is an explored prospect and workings consist of a shaft 50 feet (15m) deep and an adit 150 feet (46m) long that extends under the shaft, but has not encountered mineralization. The mine has been abandoned for several years and has probably not produced an appreciable amount of ore.

The prospect is in the Ordovician Pogonip Formation which has been fractured by fissures striking N. 40° W. and dipping 75 degrees northeasterly. The host limestone has been replaced and near the surface has been oxidized. The mineralization consists of galena, cerussite, and limonite in a siliceous gangue. A sample of stockpiled oxide ore near the shaft assayed 40 percent lead, 4.98 percent zinc, 0.094 percent copper, 0.007 ounces of gold and 27.94 ounces of silver. The ore is handcobbed and sorted and not representative. There are no known reserves in the prospect workings, but additional exploration might discover similar mineralization.

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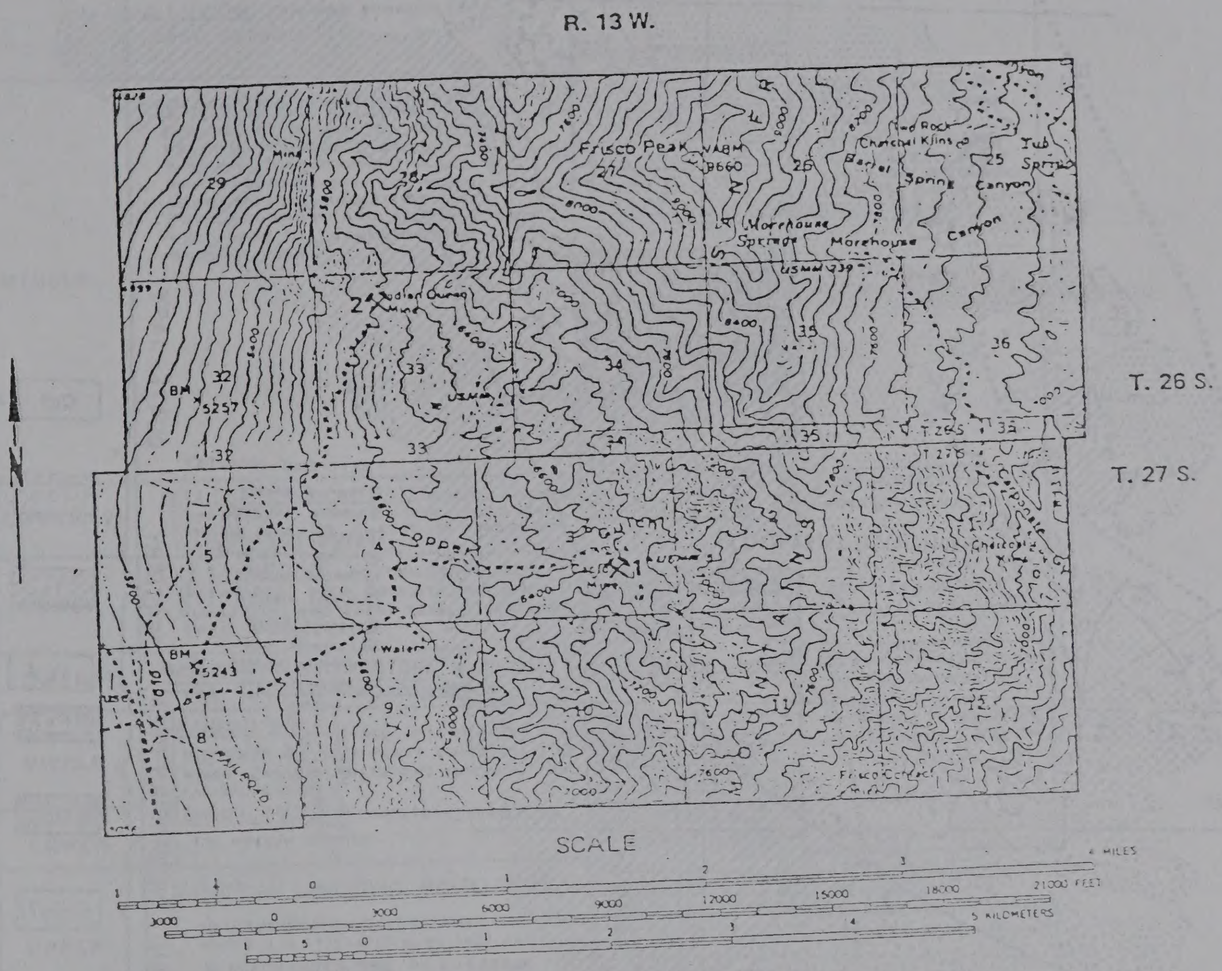
U. S. Bureau of Mines Mineral Yearbooks, 1941-1946

Newhouse (Preuss) District

The Newhouse district lies immediately north of the Frisco district in the San Francisco Mountains. Its area covers both sides of the mountain range, its southern boundary is south of the old Newhouse townsite. The district is located 18 miles (29km) west-northwest of Milford past the old Frisco townsite and Squaw Springs on Utah Highway 21. A dirt road leads northerly from the highway five miles (8km) west of Squaw Springs to the old Newhouse townsite. The mines are located to the east and north of the townsite in the San Francisco Mountains. The district is principally known for its copper production from the Cactus mine. The most important lead-zinc producing mine is the Indian Queen, which is reported to have yielded over $100,000 in lead-silver ore (Havenor and Herbst, 1908, p. 34). Figure 20 is a map of the district.

Sedimentary rocks in the district consist of the Cambrian Prospect Mountain Quartzite thrust over an Upper Cambrian-Lower Ordovician carbonate sequence (see figures 21 and 22). The sedimentary rocks are intruded by the Tertiary quartz monzonite Cactus stock. Along the eastern slope of Frisco Peak, Tertiary volcanics are faulted against the Paleozoic sediments (Golden Reef fault). The ore deposits of the district are of three types; breccia pipes, replacements in Paleozoic sediments along fissures, and siliceous gold ore in quartzite. The first is typical of the Cactus ore body, a breccia pipe lying within the Cactus stock. The second is represented by the ore-body in the Indian Queen, where lead-silver ore occurs as a replacement of carbonate rocks



NEWHOUSE DISTRICT

1. Cactus mine
2. Indian Queen mine

Figure 20: Topographic map of the Newhouse mining district

Adapted From: USGS Frisco 15′ Quadrangle
USGS Frisco Peak 15′ Quadrangle

GEOLOGIC MAP OF THE NEWHOUSE MINING DISTRICT

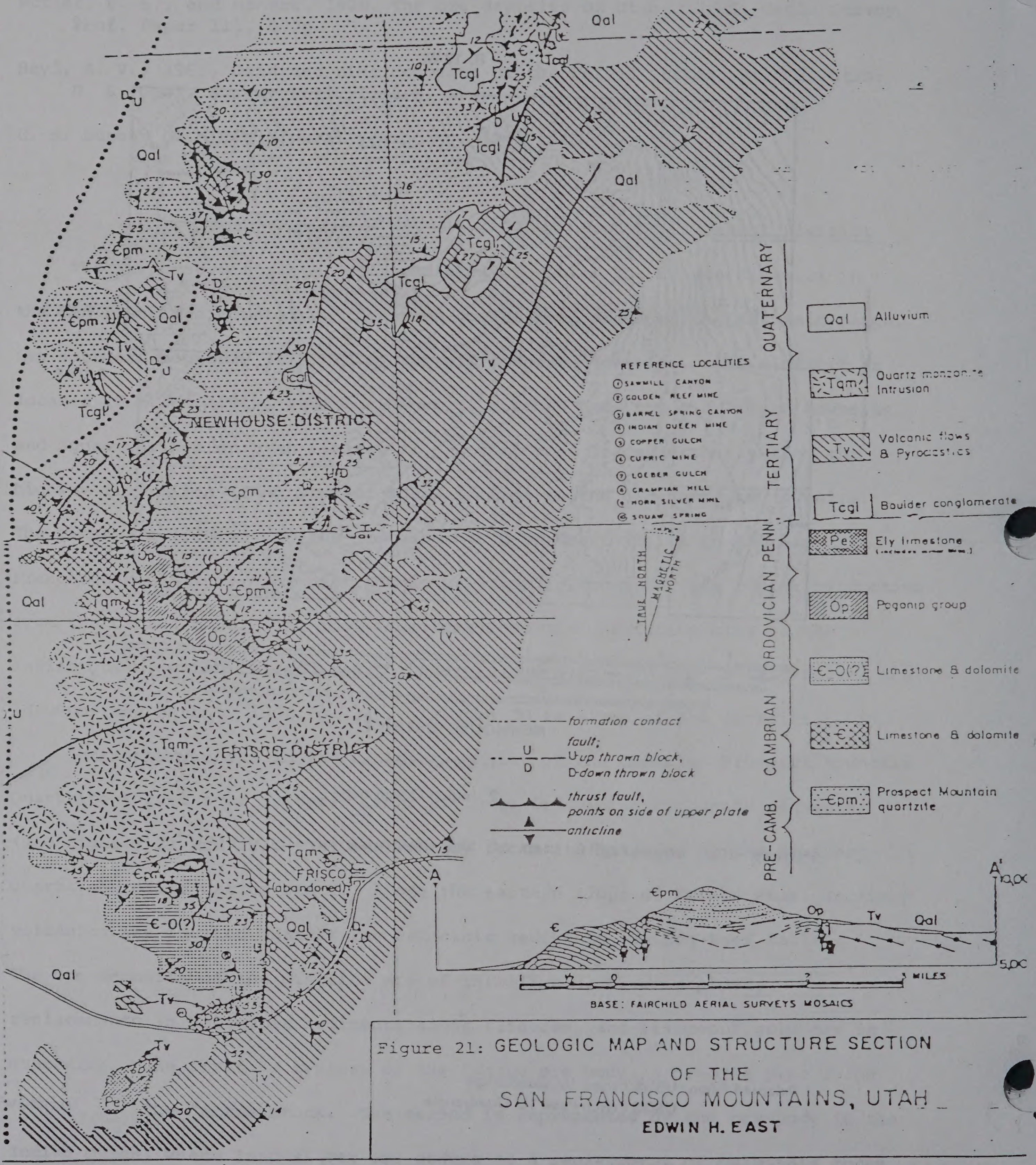


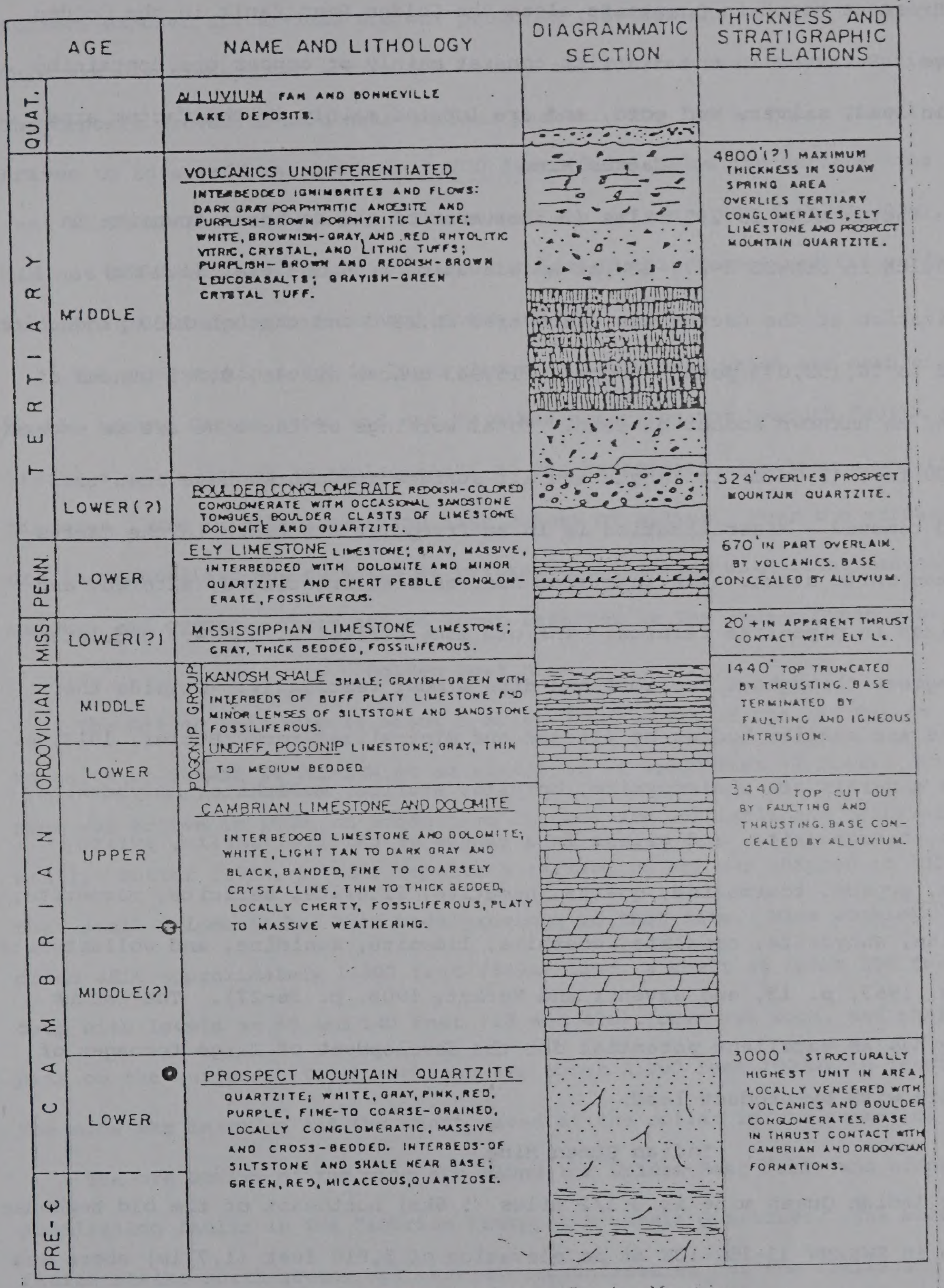
Figure 21: GEOLOGIC MAP AND STRUCTURE SECTION OF THE SAN FRANCISCO MOUNTAINS, UTAH

EDWIN H. EAST

Adapted from E.H. East, 1966

Figure 22:

STRATIGRAPHIC COLUMN FOR THE SAN FRANCISCO MOUNTAINS



AGE		NAME AND LITHOLOGY	DIAGRAMMATIC SECTION	THICKNESS AND STRATIGRAPHIC RELATIONS
QUAT.		ALLUVIUM FAN AND BONNEVILLE LAKE DEPOSITS.		
TERTIARY	MIDDLE	VOLCANICS UNDIFFERENTIATED INTERBEDDED IGNIMBRITES AND FLOWS: DARK GRAY PORPHYRITIC ANDESITE AND PURPLISH-BROWN PORPHYRITIC LATITE; WHITE, BROWNISH-GRAY, AND RED RHYOLITIC VITRIC, CRYSTAL, AND LITHIC TUFFS; PURPLISH-BROWN AND REDDISH-BROWN LEUCOBASALTS; GRAYISH-GREEN CRYSTAL TUFF.		4800'(?) MAXIMUM THICKNESS IN SQUAW SPRING AREA OVERLIES TERTIARY CONGLOMERATES, ELY LIMESTONE AND PROSPECT MOUNTAIN QUARTZITE.
	LOWER(?)	BOULDER CONGLOMERATE REDDISH-COLORED CONGLOMERATE WITH OCCASIONAL SANDSTONE TONGUES, BOULDER CLASTS OF LIMESTONE DOLOMITE AND QUARTZITE.		524' OVERLIES PROSPECT MOUNTAIN QUARTZITE.
PENN.	LOWER	ELY LIMESTONE LIMESTONE; GRAY, MASSIVE, INTERBEDDED WITH DOLOMITE AND MINOR QUARTZITE AND CHERT PEBBLE CONGLOMERATE, FOSSILIFEROUS.		670' IN PART OVERLAIN BY VOLCANICS. BASE CONCEALED BY ALLUVIUM.
MISS.	LOWER(?)	MISSISSIPPIAN LIMESTONE LIMESTONE; GRAY, THICK BEDDED, FOSSILIFEROUS.		20'+ IN APPARENT THRUST CONTACT WITH ELY Ls.
ORDOVICIAN	MIDDLE	POGONIP GROUP KANOSH SHALE SHALE; GRAYISH-GREEN WITH INTERBEDS OF BUFF PLATY LIMESTONE AND MINOR LENSES OF SILTSTONE AND SANDSTONE. FOSSILIFEROUS.		1440' TOP TRUNCATED BY THRUSTING. BASE TERMINATED BY FAULTING AND IGNEOUS INTRUSION.
	LOWER	UNDIFF. POGONIP LIMESTONE; GRAY, THIN TO MEDIUM BEDDED		
CAMBRIAN	UPPER	CAMBRIAN LIMESTONE AND DOLOMITE INTERBEDDED LIMESTONE AND DOLOMITE; WHITE, LIGHT TAN TO DARK GRAY AND BLACK, BANDED, FINE TO COARSELY CRYSTALLINE, THIN TO THICK BEDDED, LOCALLY CHERTY, FOSSILIFEROUS, PLATY TO MASSIVE WEATHERING.		3440' TOP CUT OUT BY FAULTING AND THRUSTING. BASE CONCEALED BY ALLUVIUM.
	● MIDDLE(?)			
	LOWER	● PROSPECT MOUNTAIN QUARTZITE QUARTZITE; WHITE, GRAY, PINK, RED, PURPLE, FINE- TO COARSE-GRAINED, LOCALLY CONGLOMERATIC, MASSIVE AND CROSS-BEDDED. INTERBEDS OF SILTSTONE AND SHALE NEAR BASE; GREEN, RED, MICACEOUS, QUARTZOSE.		3000' STRUCTURALLY HIGHEST UNIT IN AREA, LOCALLY VENEERED WITH VOLCANICS AND BOULDER CONGLOMERATES. BASE IN THRUST CONTACT WITH CAMBRIAN AND ORDOVICIAN FORMATIONS.
PRE-€				

Composite columnar section, San Francisco Mountains.

Adapted from E.H. East, 1966, p.904

● Ore-bearing horizons

along a fissure. The siliceous gold ore is represented by breccia fillings in the Prospect Mountain Quartzite along the Golden Reef fault in the Golden Reef mine. Reserves in the district consist mainly of copper ore containing values in lead, silver, and gold, and are located mainly in the Cactus area.

Cactus Mine

The Cactus mine is 2.5 miles (3.5km) east of the Newhouse townsite in Copper Gulch in SENWSE 3-27S-13W at an elevation of 6,363 feet (1,939m). Mineralization at the Cactus was discovered in 1870 and through 1939 production amounted to 24,155,073 pounds copper, 216,943 ounces silver, 9,535 ounces of gold, and an unknown amount of lead. Total workings of the mine are in excess of 10,000 feet (3,048m) in length and all surface structures have been torn down and removed. Mineralization is in an irregular stockwork in the Cactus quartz monzonite stock. The intrusive host as been brecciated, altered, and mineralized in pipe-like fashion. The ore zone strikes N. 55° W., undulates a few degrees throughout the zone and dips almost vertically. Outside the main zone are smaller bodies of altered and mineralized rock (Butler, 1913, p. 174).

Ore minerals are chalcopyrite, bornite, azurite, malachite, molybdenite, stibnite, tetrahedrite, and galena in a gangue of calcite, barite, pyrite, siderite, gypsum, tourmaline, quartz, hematite, fluorite, sericite, magnetite, serpentine, anhydrite, cosalite, goethite, limonite, sanidine, and wollastonite (Bullock, 1967, p. 15, and Havenor and Herbst, 1908, p. 26-27). The Cactus property has an excellent potential for the development of large tonnages of copper ore with by-product lead.

Indian Queen Mine

The Indian Queen mine is 3 1/2 miles (5.6km) northeast of the old Newhouse townsite in SWNENW 33-26S-13W at an elevation of 5,810 feet (1,771m) above sea level. The Indian Queen is part of a large group of patented claims covering Upper Cambrian rock on the north side of the Cactus stock. The first claim was located prior to 1870 was known as the Mountain Queen and early literature refers to the Indian Queen mine by this name. From this mine over $100,000 of surface-exposed silver-lead ore was produced (Havenor and Herbst, 1908, p. 34). This ore was transported across the valley and smelted near Wah Wah Springs. The deposit proved to be a near-surface pocket. The Indian Queen Tunnel was driven to intersect the ore body 1,200 feet (366m) below the surface some 4,000 feet (1,219m) from the portal. The tunnel was driven 4,600 feet (1,402m) and did not intercept ore. Mine workings consist of this tunnel and the surface workings of several prospects and short adits.

The mine workings are in Upper Cambrian limestones which are marbleized by the nearby Cactus stock and cut by dikes occupying north-south faults and fissures. Ore occurs as replacements of the brecciated limestone along the fissures. Ore is galena carrying high values of silver. Near the surface the ore is mineralized and consists of cerussite associated with iron, manganese oxides, and gypsum. There are no known reserves in the Indian Queen mine.

Golden Reef Mine

The Golden Reef mine is about 5 miles (8km) north of the old Frisco townsite in SWSWNE 24-26S-13W at an elevation of 7,600 feet (2,316m). The mine was active in 1909, no production figures are available and believed small. Butler (1913, p. 186) reports a carload of ore was shipped in 1909 and that small shipments had been made previous to that date. Mine workings consist of an adit approximately 1,800 feet (549m) long, a shaft at least 200 feet (61m) deep with levels at 60 and 140 feet (18 and 43m), open cut work, and shallow pits on the surface. Total workings are about 2,700 feet (823m) in length. The mine was inactive and the shaft caved at the collar in the summer of 1976.

The ore bodies of the mine are along the Golden Reef fault and along paralleling faults in the Cambrian Prospect Mountain Quartzite. The main faults strike north-south, but several cross-fissures cut the faults and are expressed as breccia zones. The most prominent fissure is the Galena striking N. 60-65° E. Butler reports the siliceous oxidized ore to carry more than an ounce of gold with a rather low lead content and a little silver. Sulfide ore contains less gold and is richer in lead. The primary mineral is galena which has been oxidized to cerussite near the surface. Minerals identifiable in the mine are gold, galena, cerussite, pyrite, limonite, hematite, barite, and quartz. There are no reserves in the Golden Reef mine.

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Pine Grove District

The Pine Grove district is located 33 miles (53km) west-southwest of Milford in the Wah Wah Mountains at an elevation of about 7,000 feet (2,134m). The district can be reached by driving west from Milford on Utah Highway 21 for 38 miles (61.1km), turning south on a road along Pine Valley for 10 miles (16km) to a junction, and turning southeasterly for 8 miles (12.9km). The district was organized in 1873 and reorganized in 1879. Prior to 1911 the amount of ore shipped was probably small, after that date some records are available. The years of production extend from 1911 to 1945 and 247,022 pounds lead, 280,500 pounds zinc, 2,846 pounds copper, 16,186 ounces of silver, and 84 ounces of gold were produced valued at $59,717 (table 13). All of the above production with the exception of 80 tons in 1911 came from the Wah Wah mine. Recent (February, 1977) exploratory activity in the district has consisted of the drilling of several holes to an intrusive, but information is not yet available on the findings. A map of the district is provided as figure 23.

Sedimentary units in the district range in age from Cambrian through Devonian and igneous rocks are Tertiary in age (figures 24 and 25). The sediments have a prominent eastward dip and have been cut by a series of faults striking northwest. The zone of faulting is occupied by a Tertiary intrusive exposed near the Wah Wah mine. Ore bodies are associated with the prominent northwest trending Tasso fault zone and along another set of fractures which strike N. 15° W. The ore occurs as a replacement in limestone and consists of galena, or its oxidized minerals in a gangue of limonite and hematite. The principal ore body is along the Tasso fault in the Wah Wah mine. The district contains a large body of low-grade oxidized zinc-bearing material in the mine (Heyl, 1963, p. B95). The potential of finding additional ore in the district is good. The prospective mineralization may contain copper as the principal metal with lead and zinc as by-products.

Wah Wah (Tasso) Mine

The Wah Wah or Tasso mine, the most important in the district, is in SESWSW 26-28S-16W at an elevation of 7,440 feet (2,268m). The property consists of 22 patented claims owned by Karl Truman and presently under lease to a prominent mining company. In 1912 the Salt Lake Mining Review reported the shaft to be sunk to a depth of 130 feet (40m); in 1939 the shaft was 200 feet (61m) deep with levels established at depths of 80, 125, and 200 feet (24, 38, and 61m) containing a total of 1,000 feet (305m) of drifts and stopes (figure 26). In November, 1942, the Bureau of Mines initiated a project to dewater the Tasso shaft and drill out, sample, and map the mine (Jones and Dunham, 1946, p. 1). The mine has produced 2,747 tons of ore containing 242,675 pounds lead, 280,500

Table 13: Production of metals from the Pine Grove District, Beaver County, Utah

	Ore	Gold		Silver		Copper		Lead		Zinc		Total
Year	S. Tons	Ounces	Value	Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	Value
1911	80	2.14	$44	5,052	$2,677	170	$21	4,347	$195	---	---	$2,937
1919	31	4.12	85	1,213	1,359	118	22	8,072	428	---	---	1,894
1920	42	0.51	10	1,303	1,420	85	15	1,113	89	---	---	1,534
1938	36	8.00	280	560	362	---	---	11,500	529	---	---	1,171
1939	889	57.00	1,995	6,871	4,664	1,173	122	185,490	8,718	---	---	15,499
1943	138	2.00	70	405	288	300	39	10,400	780	3,500	$378	1,555
1944	102	---	---	159	113	200	27	7,100	568	6,000	684	1,392
1945	1,509	11.00	385	623	443	800	108	19,000	1,634	271,000	31,165	33,735
Totals	2,827	84.77	$2,869	16,186	$11,326	2,846	$354	247,022	$12,941	280,500	$32,227	$59,717
Average grade		0.03oz.		5.72oz.		0.05%		4.36%		4.96%		

Above figures are only for years shown.

Source: U. S. Bur. Mines Mineral Yearbooks, various years.

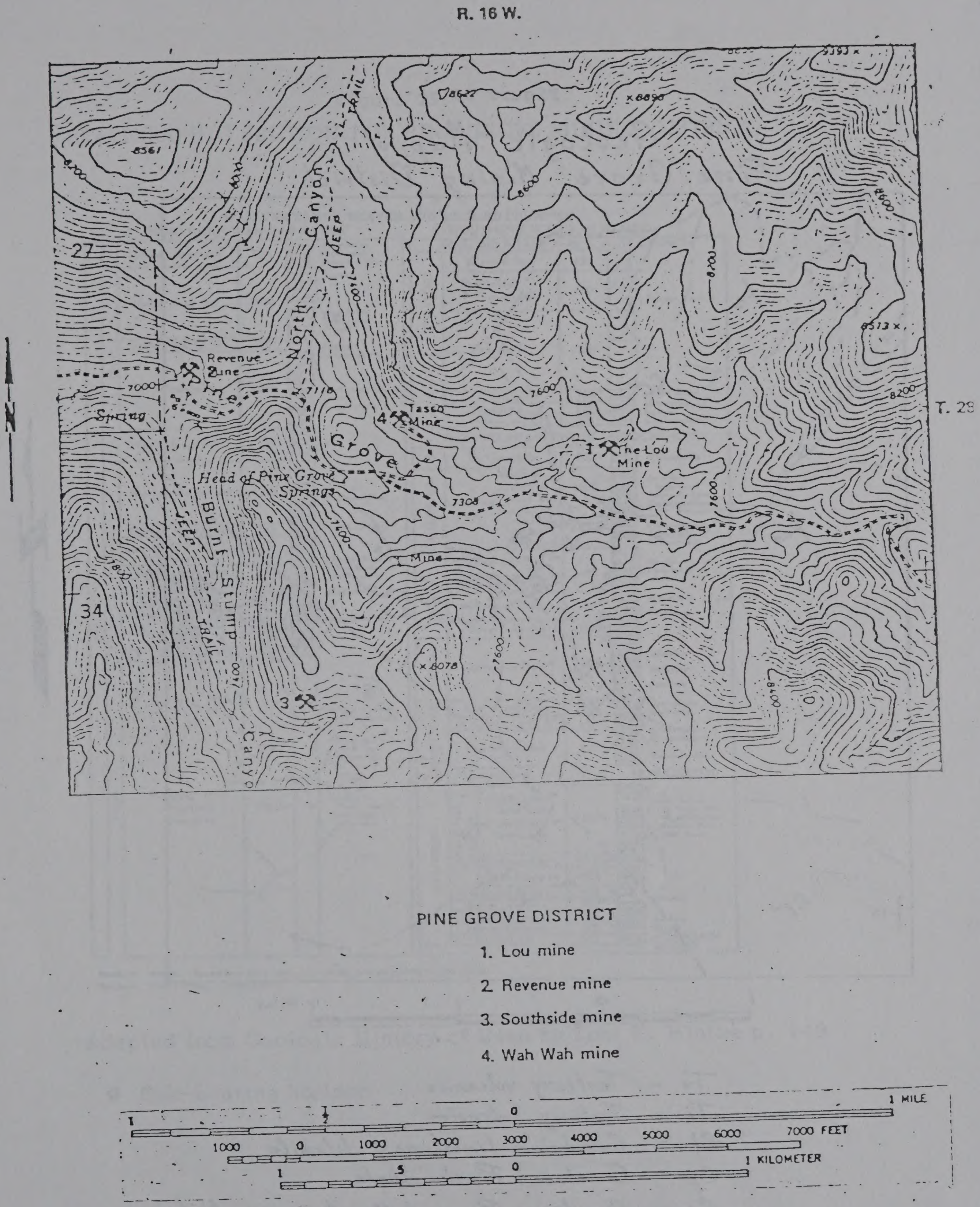
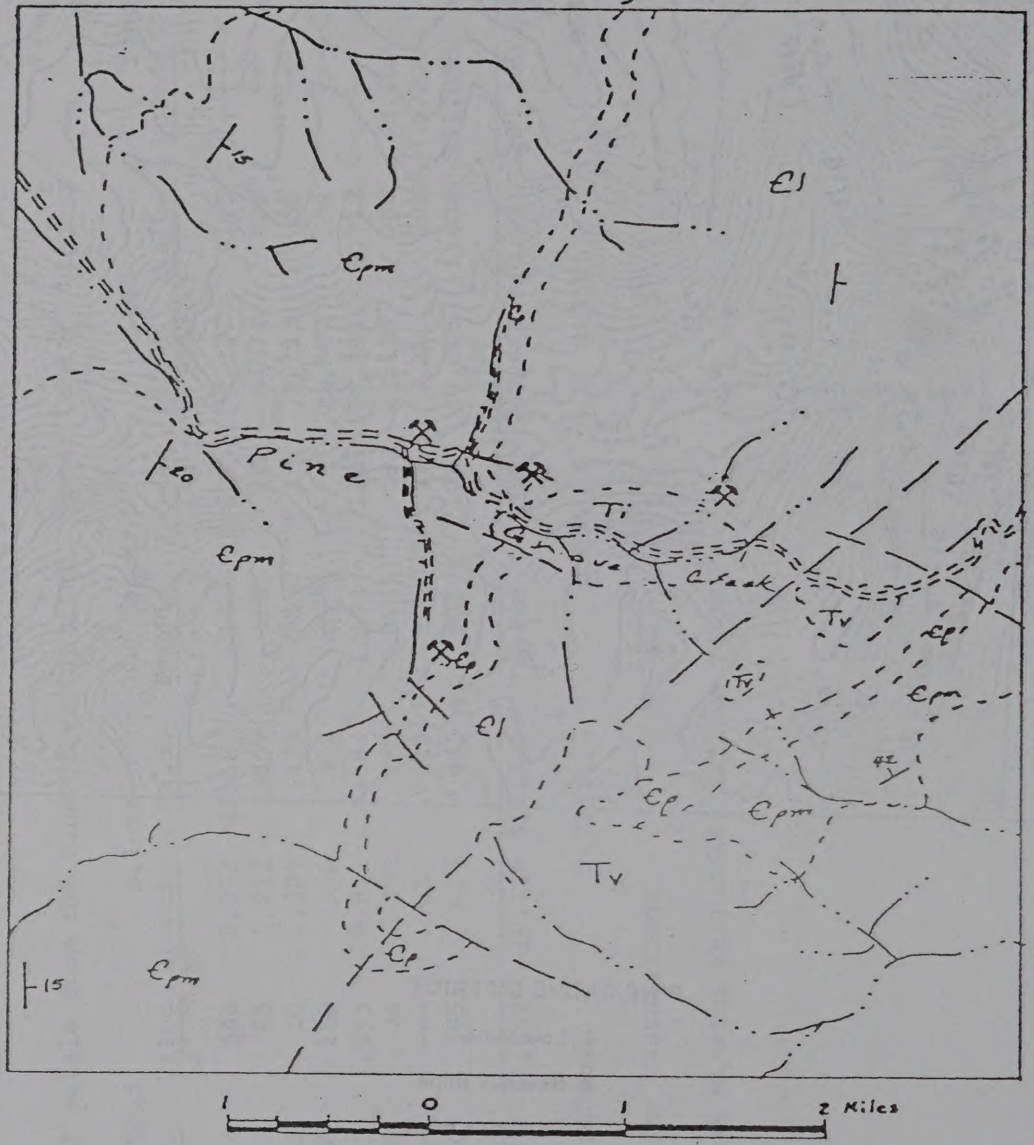


Figure 23: Topographic map of the Pine Grove mining district
Adapted From: USGS Lamerdorf Peak 7½' Quadrangle

Figure 24:

Geologic Map of Pine Grove Mining District

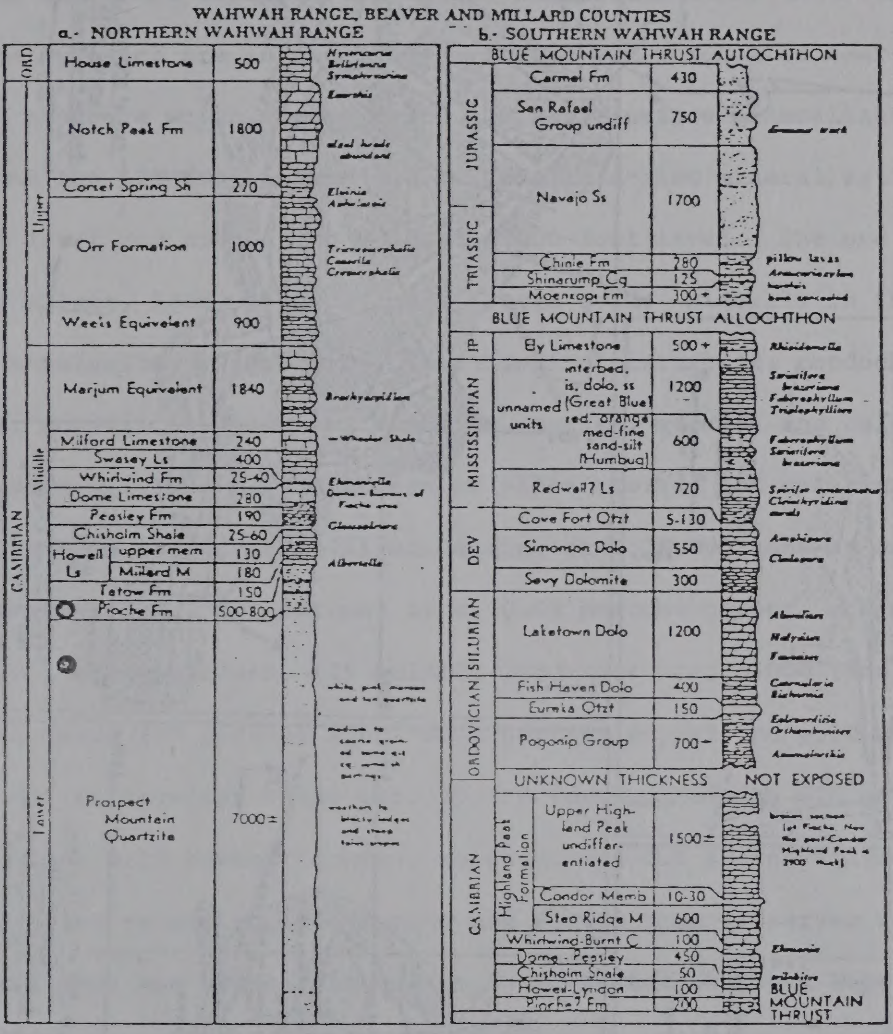


Tv - Tertiary volcanics
Ti - Tertiary intrusive
Ꞓl - Cambrian limestone & dolomite
Ꞓp - Cambrian Pioche shale
Ꞓpm Cambrian Prospect Mountain quartzite
— — Fault
- - - - Contact

Geology from Taylor and Powers, 1953

Figure 25:

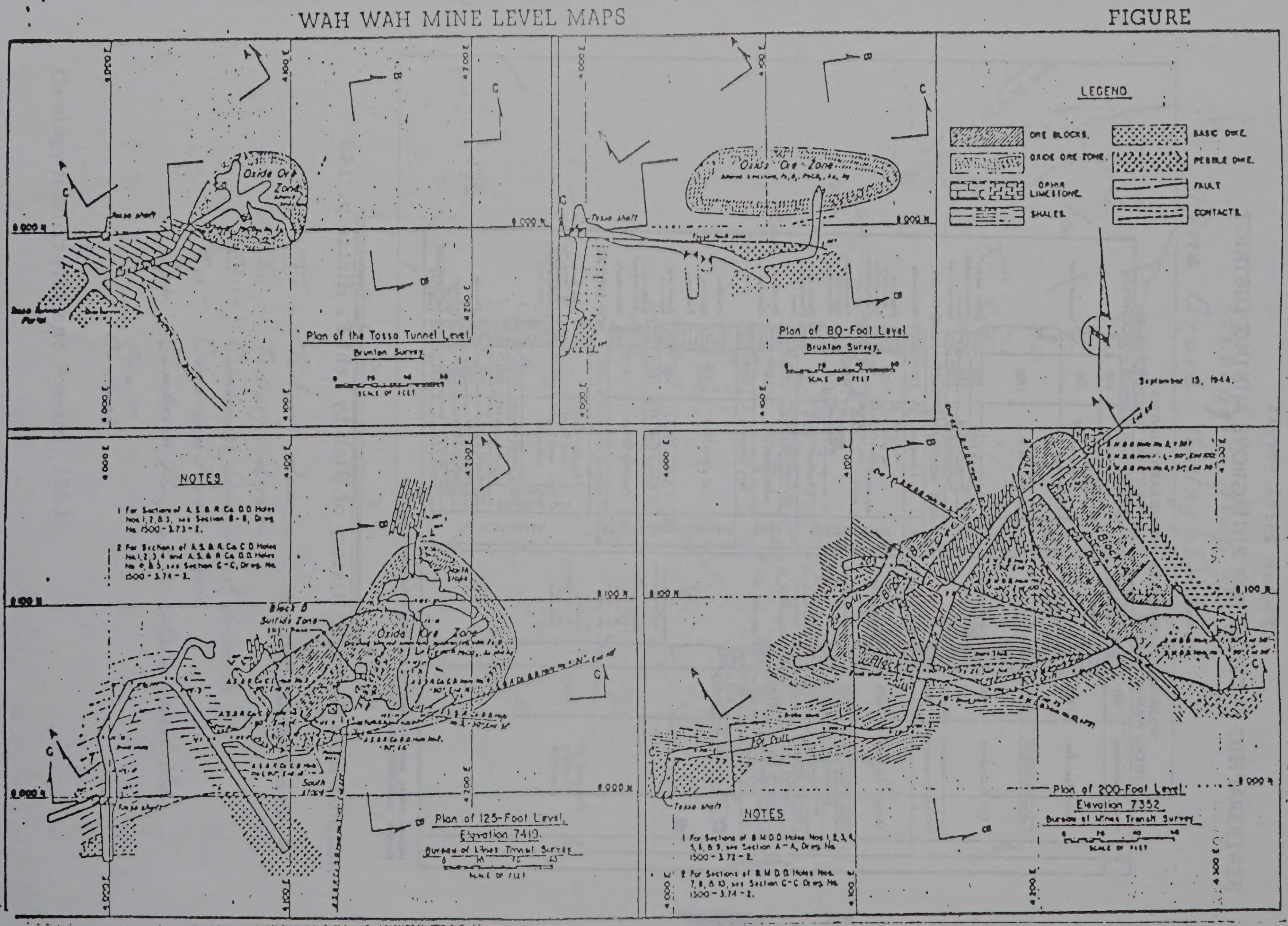
STATIGRAPHIC SECTION FOR PINE GROVE MINING DISTRICT



Northern- Hintze, unpublished notes; Higgins (1959); Robison (1960); Kepper (1972)
Southern. Miller (1966), Olmore (1972)

Adapted from Geologic History of Utah by Lehi F. Hintze p. 149

● Ore-bearing horizon



NOTES

1 For Sections of A.S.& R. Co. D.D. Holes Nos 1, 2, & 3, see Section B-B, Drwg. No. 1500-3.73-2.

2 For Sections of A.S.& R. Co. C.D. Holes No. 1, 2, 3, 4 and A.S.& R. Co. D.D. Holes No. 4, & 5, see Section C-C, Drwg. No. 1500-3.74-2.

NOTES

1 For Sections of B.M.D.D. Holes Nos 1, 2, 3, 4, 5, 6, & 9, see Section A-A, Drwg. No. 1500-3.72-2.

2 For Sections of B.M.D.D. Holes Nos. 7, 8, & 10, see Section C-C Drwg. No. 1500-3.74-2.

Adapted from Bureau of Mines report of investigation # 3853 by Jones and Dunham, figure 3

Figure 26: Level maps for the Wah Wah mine, Pine Grove district, Beaver County, Utah

pounds zinc, 2,676 pounds copper, 11,134 ounces silver, and 83 ounces gold.

The orebodies in the mine are associated with the Tasso fault zone which strikes N. 70° W. and dips 70 degrees to the northeast. The displacement is 700 feet (213m) in the area of the mine, ore bearing solutions have migrated along the fault and replaced the Pioche Shale limestones and shales. There are three types of ore in the mine; oxidized ore which lies near the surface, oxidized zinc ore which occurs below the near surface mineralization and extends to the 125-foot level, and sulfide lead-zinc mineralization below the 125-foot level and continuing below the 200-foot level. The ore principally contains silver, lead, copper, and a little gold. Minerals in the mine include galena, sphalerite, chalcopyrite, smithsonite, cerussite, rhodochrosite, ankerite, covellite, limonite, hematite, pyrite, quartz, and calcite.

Diamond drilling by the Bureau of Mines blocked out reserves and classified them into three categories; (1) oxide zinc ore, 38,000 tons at an average grade of 2.5 percent lead, 2.5 percent zinc, 0.05 percent copper, and 0.01 ounce gold, and 5 ounces silver, (2) sulfide lead-zinc ore, 8,000 tons containing 1 percent lead, 1.5 percent zinc, 0.02 percent copper, no gold and 4 ounces silver, (3) silver-lead oxide ore, 20,000 tons containing 0.5 percent lead, 2.5 percent zinc, 0.05 percent copper, no gold, and 0.5 ounces silver to the ton. Total reserves remaining in the mine are 66,000 tons (reserves were calculated from level maps and cross-sections in U. S. Bureau of Mines Report of Investigation No. 3853).

Lou (Lue) Mine

The Lou mine is located about 3,000 feet (914m) east of the Wah Wah mine in NENWNW 36-28S-16W at an elevation of 7,330 feet (2,234m), and is a part of the 22 patented claims of Karl Truman. The only recorded production from the mine was in 1911 and consisted of 80 tons of ore containing 2.14 ounces gold, 5,052 ounces silver, 170 pounds copper, 4,347 pounds lead, and no zinc, having a value of $2,937. Workings consist of a vertical shaft and two inclined shafts.

The north incline was caved at the time of visit and the other was flooded to 75 feet (23m) below the shaft collar. Both shafts are inclined at approximately 30 degrees.

Ore occurs as a replacement in the Swasey Limestone where it is in contact with the intrusive. Minerals observed are cerussite, smithsonite, limonite, hematite, pyrite, and calcite. There are no known reserves in the mine. The mine is referenced by the Salt Lake Mining Review, January 15, 1915, and in the aforementioned Bureau of Mines Report of Investigation.

Revenue Mine

The Revenue mine is on the north side of Pine Grove in NWSWSW 26-28S-16W at an elevation of 7,040 feet and may have been the first of the district. Mine workings are entirely in the Prospect Mountain Quartzite and consist of two adits, the upper one caved and the lower open. The upper adit was driven in the early days of the camp and some high-grade lead-silver-gold ore was probably shipped. The lower adit was driven in the 1950s to intersect the mineralized zone at depth. The zone was intercepted, but it had pinched and there was no ore. The lower adit is about 900 feet (274m) in length. The mine is in the Tasso fault zone where the quartzite has been brecciated. Ore-bearing solutions filled the voids surrounding the quartzite fragments. The near surface mineralization is oxidized and is locally high in gold values. The Tasso fault zone strikes N. 70° W. and dips steeply to the northeast. The mined ore contained a high hematite content and was probably in good demand as a smelter flux. There are no reserves remaining in the mine.

Southside Mine

The Southside mine is in the Left Fork of Burnt Stump Canyon in SWNESW 35-28S-16W at an elevation of 7,660 feet (2,335m). The mine is on the Southside patented claim, one of the 22 owned by Karl Truman. Mine workings consist of two adits, an upper and lower, both driven into the Prospect Mountain Quartzite. The upper adit consists of approximately 700 feet (213m) of drifts along a fault striking N. 5° W. and dipping 80 degrees to the east. The vein occupying the fault is composed of brecciated quartzite fragments, hematite, cerussite, galena, and silver and gold in an unidentified form. The fault, which the vine occupies, is premineral and displacement is probably less than 100 feet (30m). The lower adit is about 100 feet (30m) lower in elevation and consists of at least 400 feet (122m) of drifts along the same vein. The drift is presently caved in the face and a considerably greater length of workings may be present. Some ore was probably shipped from the mine although there is no record of it. Reserves in the mine are small, ore tends to occur as small pods. A reserve estimate ranging from 25 tons (90 percent possibility) to 500 tons (10 percent possibility) is fair. The ore will have an average grade of 20 percent lead, 10 ounces silver, and 0.2 ounces of gold to the ton.

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Star District

The Star mining district includes the North and South Star districts, organized on November 11, 1871, and on July 8, 1870, respectively. The district

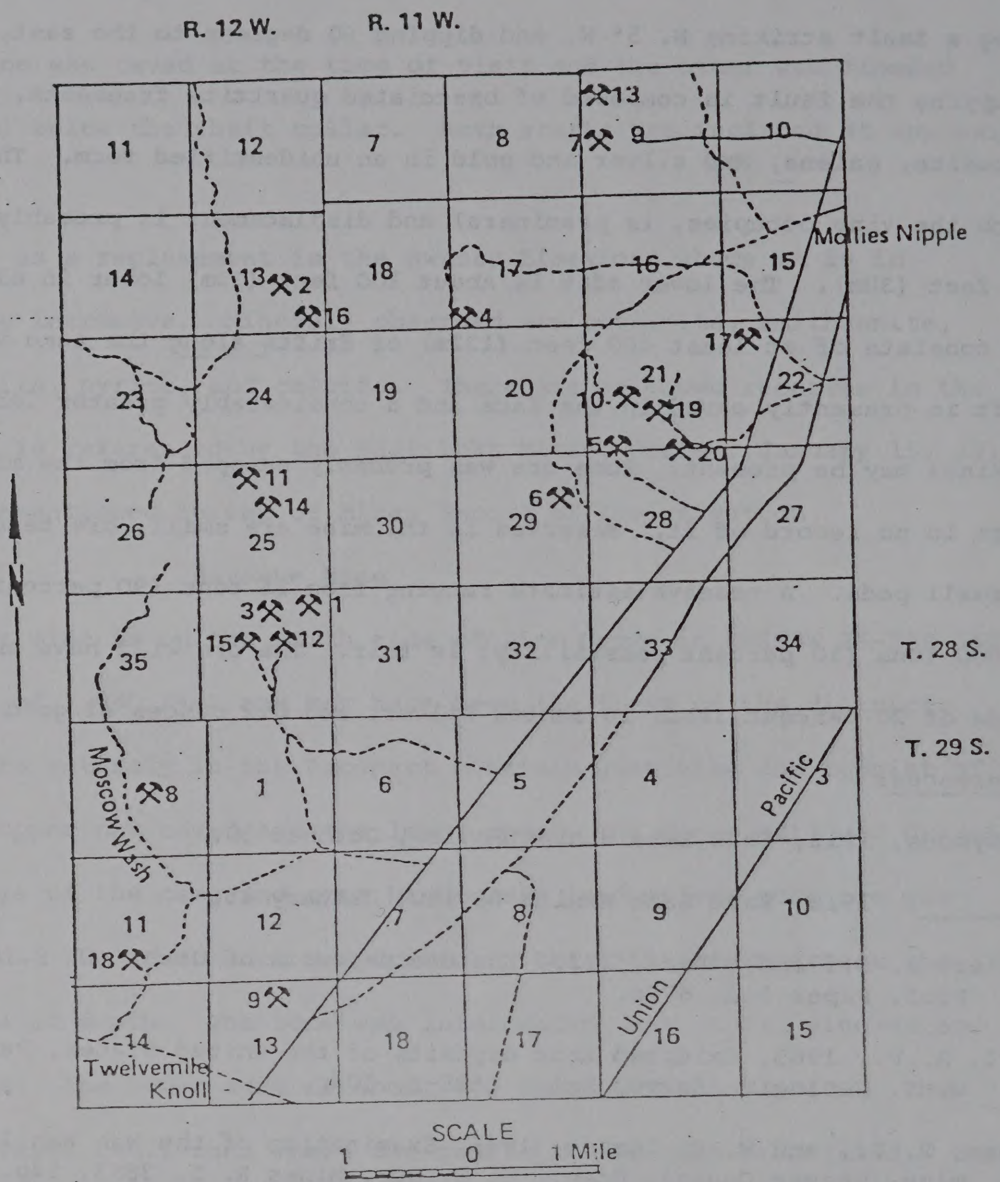


Figure 26: Outline map of the Star mining district, Beaver Co., Utah

STAR DISTRICT

1. Atlas mine
2. Cedar-Talisman mine
3. Commonwealth mine
4. Emerson mine
5. Estelle mine
6. Gold Crown mine
7. Harrington-Hickory mine
8. Magnolia mine
9. Mammoth Lode mine
10. Maude S. mine
11. Mowitza mine
12. Progressive mine
13. Rebel mine
14. Red Warrior mine
15. St. Mary's mine
16. Silver Bug mine
17. Sundown mine
18. Velvet Silver mine
19. Vicksburg mine
20. Woodhouse shafts

Adapted From: USGS Milford 15' Quadrangle

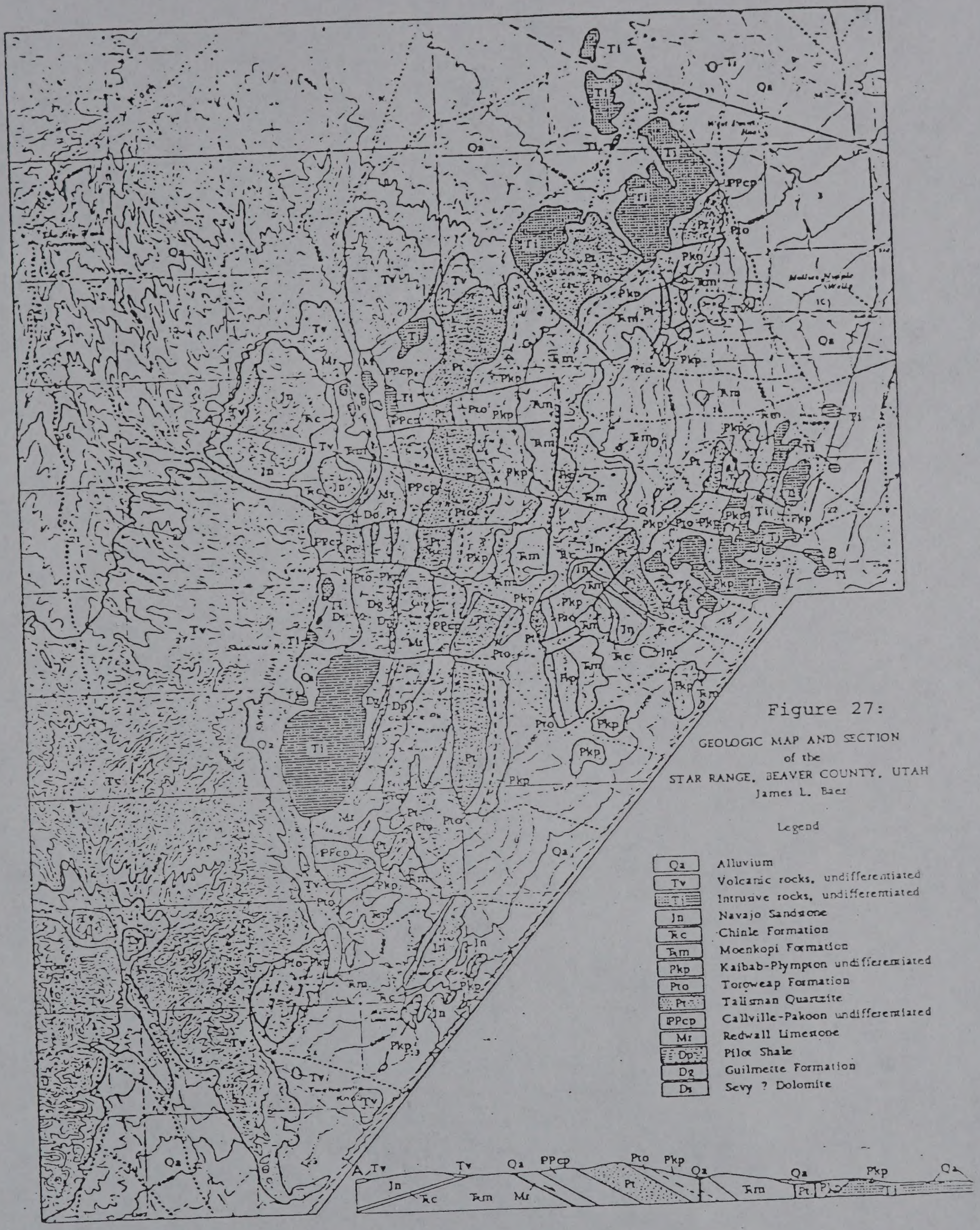


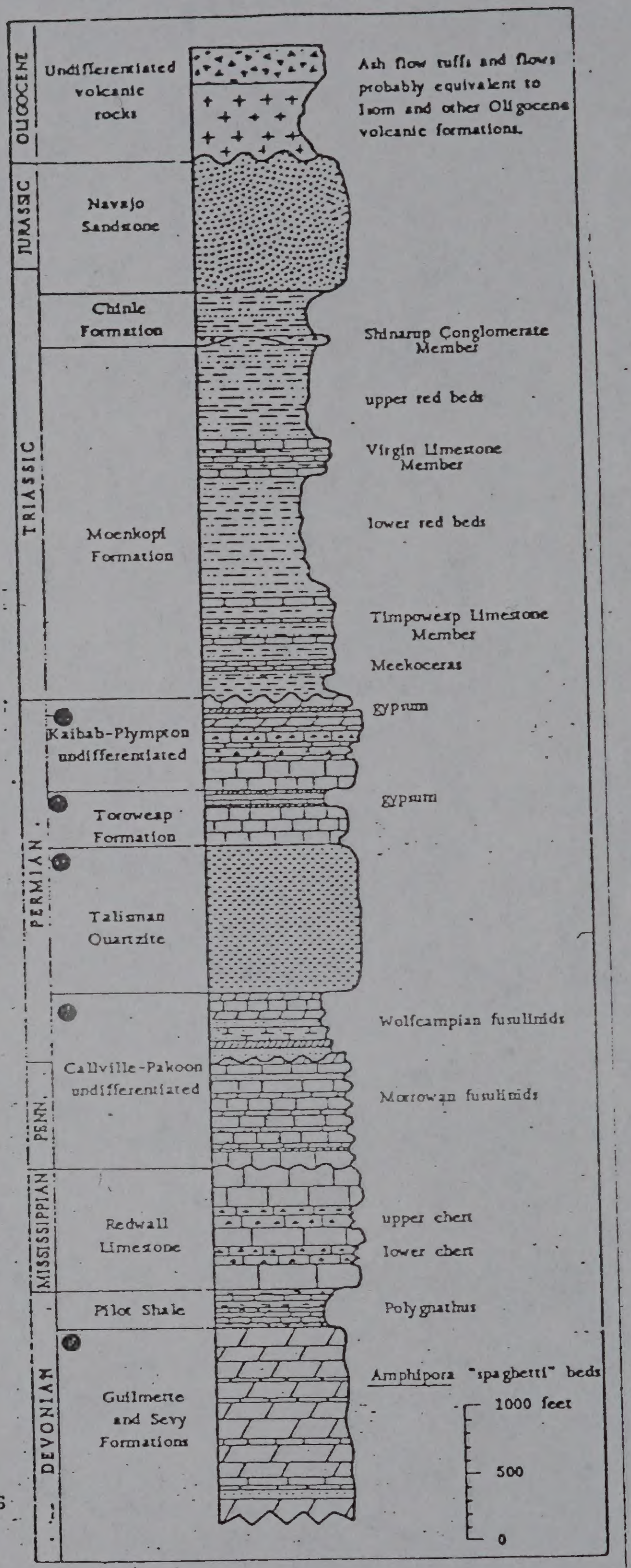
Figure 27:

GEOLOGIC MAP AND SECTION of the STAR RANGE, BEAVER COUNTY, UTAH

James L. Baer

Geologic map and section of the Star Range, Beaver County, Utah.

Adapted from Summary of stratigraphy and structure of the Star range, Beaver County, Utah by James L. Baer in Geology of the Milfrod Area 1973, p.34.



● Ore-bearing horizons

Figure 28: Stratigraphic column of the Star Range.

Adapted from Summary of stratigraphy and structure of the Star range, Beaver County, Utah by James L. Baer in Geology of the Milford Area 1973 p. 35.

has produced 50,000,000 pounds lead, 7,000,000 pounds zinc, 2,000,000 pounds copper, 2,000,000 ounces of silver, 4000 ounces gold and a minor amount of tungsten having a value of $5,300,000 at the time of production (table 14). Important mines in the district are the Red Warrior, Cedar-Talisman, Harrington-Hickory, and Mowitza. The Star district is located in the southern end of the Star Range about 8 miles (12.9km) southwest of Milford (figure 26).

Sedimentary rocks in the district range from the Devonian Sevy Dolomite to the Jurassic Navajo Sandstone (Baer, 1973, p. 35). Igneous rocks consist of Oligocene ash fall tuffs and flows and quartz monzonite and granodiorite stocks (see figures 27 and 28). The Star Range structure is an eastward dipping homocline that has been block faulted. The range is believed to be an upper part of a thrust that pre-dates block faulting. The ore bodies of the district are in fissures along faults and fractures and ore replacements of selective carbonate horizons adjacent to faults. The ore bodies are controlled by the faults and fractures and by the intersections of faults with favorable carbonate horizons. Mineralization consists of silver-lead-zinc ores containing varying amounts of copper and gold. Near surface ore bodies have been oxidized and enriched producing bonanza ore containing high values in gold and silver. A great potential remains for finding additional major ore bodies. The near surface ores are mined out.

Harrington-Hickory Mine

The Harrington-Hickory mine is 4 3/4 miles (7.6km) due west of Milford in the NWNWSW 9-28S-11W at an elevation of 5,430 feet (1,655m) above sea level. Mineralization was discovered in the late 1860s and first production was achieved in 1870. Production records prior to 1910 are incomplete, but it is estimated that 7,500 tons of ore containing 22 percent lead, and 18 ounces of silver to the ton were produced (Allsman, 1949, p. 15). In 1900 the property was acquired by Majestic Mines Co., who operated it until 1912. In 1933 the

Table 14: Production of metals from the Star Mining District, Beaver County, Utah

Year	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Tons	Value
1870-1902	11,000,000	---	---	750.00	500,000	?	$1,100,000
1903	?	?	?	?	?	?	?
1904	93,000	2,391	62,500	36.28	10,310	1,100	17,580
1905	738,149	---	128,000	247.00	45,300	1,714	86,088
1906	556,300	---	67,994	60.50	34,603	1,985	69,267
1907	597,282	106,008	176,896	73.05	49,179	4,265	107,258
1908	1,144,329	54,902	94,276	71.40	41,550	2,835	86,583
1909	2,198,484	---	129,449	39.23	67,098	4,343	147,065
1910	2,300,102	61,854	141,533	53.84	88,628	4,660	171,491
1911	2,051,357	---	86,299	68.79	51,809	4,734	131,979
1912	2,916,957	2,820	67,875	63.60	51,355	5,144	175,554
1913	3,875,524	25,262	124,457	34.81	153,774	8,728	284,828
1914	3,840,954	---	58,286	284.79	131,426	7,096	236,115
1915	2,452,716	165,628	21,374	33.73	103,542	4,693	192,749
1916	1,717,284	467,734	153,696	123.84	49,188	7,823	253,903
1917	1,703,957	588,106	175,170	710.51	14,688	10,689	323,380
1918-1933	15,432,988	150,643	433,237	841.00	512,779	?	1,630,000
1934	1,892	---	3,700	0.80	449	36	684
1935	4,975	---	24	2.20	295	29	490
1936	1,326	---	---	1.20	71	6	158
1937	75,000	8,400	1,818	3.00	1,863	193	6,737
1938	105,825	4,479	1,990	6.00	2,543	321	7,132
1939	36,979	89,269	3,164	16.00	1,454	303	8,256
1940	85,420	501,651	33,000	8.00	10,395	1,324	47,276
1941	30,400	697,000	42,000	19.00	8,647	1,965	65,778
1942	42,400	142,700	5,300	5.00	1,710	542	18,144
1943	41,400	719,500	42,500	10.00	9,990	2,136	93,790
1944	262,500	273,500	40,800	28.00	19,717	3,067	72,680
1945	870,500	581,600	26,000	83.00	32,985	4,407	171,618
1946	1,039,000	943,500	66,000	57.00	42,448	6,150	275,343
1947	714,500	1,032,000	98,400	133.00	36,758	9,051	286,345
1948	156,400	15,900	12,600	199.00	13,396	3,728	51,933
1949	54,000	44,800	1,000	20.00	3,613	612	18,254
1950			no production				
1951	89,000	86,500	4,000	12.00	6,719	793	38,609
1952	79,000	49,000	5,000	23.00	8,509	796	30,569
1953-1955			no production				
1956	8,000	---	1,300	2.00	289	46	2,141

Table 14 continued:

Year	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Tons	Value
1957	51,500	42,500	3,700	5.00	7,090	1,318	$20,000
1958-1959	30,000	15,000	3,000	8.00	1,500	?	7,539
1960	23,700	27,700	1,800	3.00	1,542		8,529
1961	24,200	29,500	3,000	4.00	4,027		10,906
1962	4,400	4,300	800	1.00	1,240		2,367
1963	4,400	3,800	700	1.00	974		2,195
1964-1976			no production				
Totals:	56,456,100	6,937,947	2,322,738	4,142.57	2,123,453	(Incomplete)	$6,261,313
Whelan's (1973, p. 1) estimate:							
	50,000,000	7,000,000	2,000,000	4,000.00	2,000,000		$5,300,000

Sources:

1870-1917	Butler and others, 1920
1918-1933	Rough estimate
1934-1957	U. S. Bureau of Mines Mineral Yearbooks
1958-1959	Rough estimate
1960-1973	U. S. Bureau of Mines Mineral Yearbooks
1974-1976	District known to be inactive

property was acquired at a tax sale by a group from Beaver, Utah, the New Majestic Mining Co. (Townsend, 1953, p.2). Mine development was done under lease after 1933 and a partial record of shipments show 14 lots totaling 548 tons containing 18.1 ounces silver to the ton and 21 percent lead. A $5,000 rehabilitation loan was obtained from the Reconstruction Finance Corporation in August 1943, with which 5 miles (8.0km) of road from Milford to the plant were improved and with which a necessary building for the shaft plant was erected. The Gomer shaft was repaired and flooded parts of the mine were dewatered. Based on this work and the sampling of exposed ore in the mine an additional $6,000 loan in November, 1943 and a mining loan of $30,000 in December, 1943 were granted by the Reconstruction Finance Corporation. These funds were to equip the mine for full scale mining. The mine operated, 1944-1949, on a small scale using two miners and a hoistman. Production for these years totaled 11,031 dry tons containing 2,316,763 pounds lead, 2,221,332 pounds zinc, 89,970 pounds copper, 80,774 ounces silver, and 326 ounces gold. With the exception of an investigative program carried out by the U. S. Bureau of Mines in 1953, the mine has been idle since 1949.

The property consists of 9 patented and several unpatented claims which are owned by the New Majestic Mining Co. Mine workings consist of 10 shafts of which the Gomer and Adelia are the most important. The Gomer is the main shaft and has a depth of 604 feet (184m). There are 5 levels in the mine; the 200,300,400,500 and 600-foot levels. The 500′is the most extensive and contains about 2,000 feet (610m) of workings. Total workings in the mine amount to at least 3,500 feet (1,067m).

The Kaibab Formation, at the surface near the mine, strikes N. 10° E. and dips 45 degrees southeasterly. Steeper dips have been observed underground where the formation has been disturbed by faulting. The sediments have been intruded by a major quartz monzonite intrusive which is exposed at the surface 3/4 mile (1.2km) to the north. A light green porphyritic dike has been mapped on the surface just south of the mine and is exposed in the underground workings on the 500 level. The sedimentary formations are intersected by a series of fissures that strike N. 55 to 60° E. and dip vertically or steeply to the northwest (Townsend, 1953, p. 4). Ore bodies in the mine are of two types: (1) replacements along fissures and (2) fissure fillings and replacement of favorable limestone horizons at fracture intersections. The ore along the Harrington fissure south of the Gomer shaft is of the first type, and forms a continuous pipe-like chimney which has been mined from the surface to just above the 600-foot level where it is truncated by a fault. This ore body was later relocated on the 600 level. The ore bodies south of the Adelia fissure are of the second type. Minerals in the mine are anglesite, cerussite, chalcopyrite, galena, plumbojarosite, sphalerite, silver, azurite, tetrahedrite, corkite, vanadinite, sulfenite, limonite, magnetite, and pyrite (Bullock, 1967, p. 16). There are no known reserves in the mine, but the possibility of finding more ore is very good. Exploration in the area may find several ore bodies in the 1,000 to 10,000 ton range.

Rebel Mine

The Rebel mine is located 5 miles (8km) west of Milford and is in the NWSWNW 9-28S-11W at an elevation of 5,560 feet. The mine was worked in the early days and produced high-grade silver-lead ore. Total mine production is estimated at 5,000 tons (Wray, 1973, p. 41). Mine workings consist of two shafts, the main one 200 feet (61m) deep, along with four adits. There are approximately 1,000 feet (305m) of total workings on the property. These are cut in the Kaibab-Plympton undifferentiated unit. The structure is dominated by a large, tight, northeast-plunging anticline which may be related to an intrusion of quartz monzonite. Mineralization in the mine is localized along a discontinuous fissure zone striking N. 70° E. and dipping steeply to the south. The zone is traceable for at least 3,000 feet (975m), although the mine is restricted to only 400 feet (122m) of the zone. (figure 29).

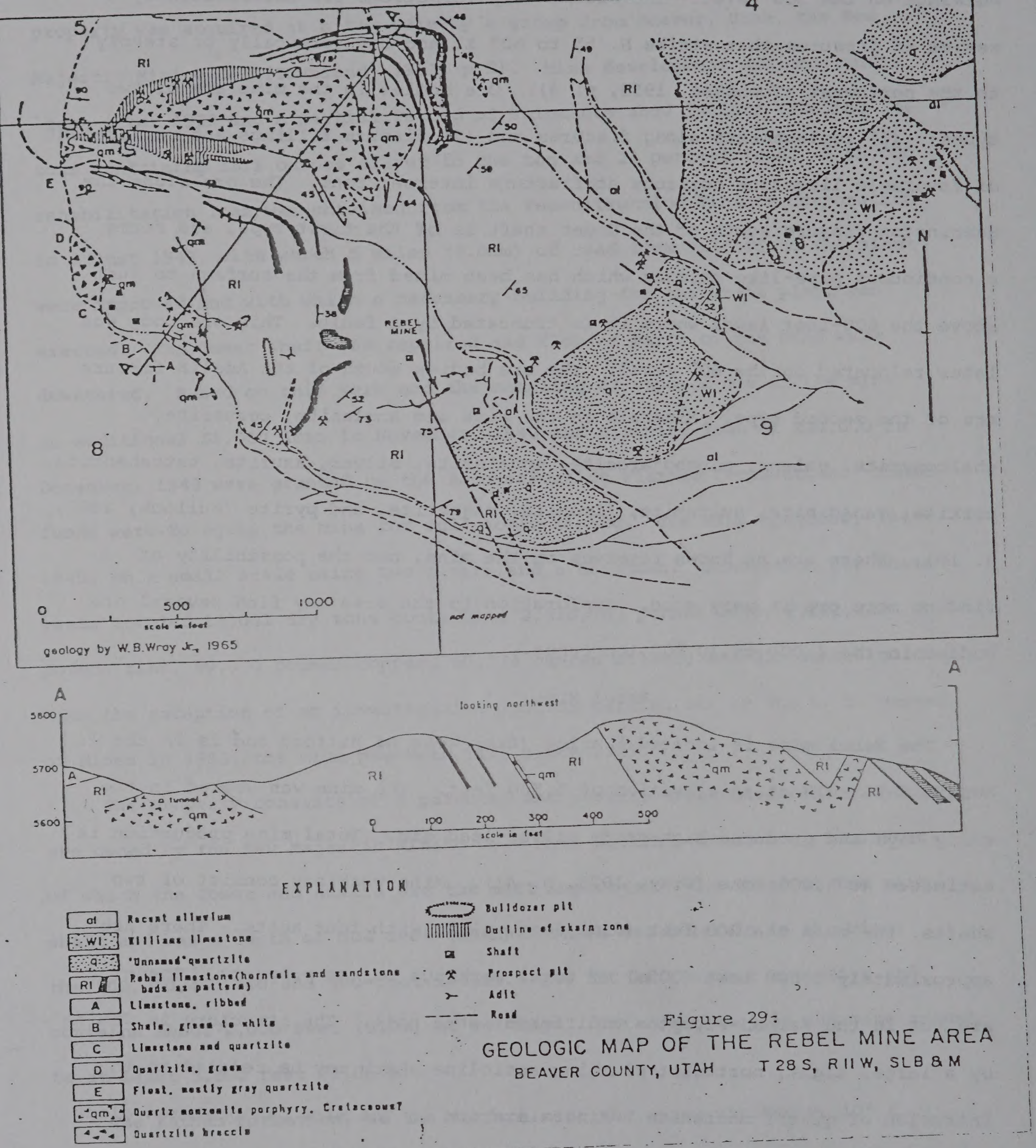


Figure 29:

GEOLOGIC MAP OF THE REBEL MINE AREA

BEAVER COUNTY, UTAH T 28 S, R 11 W, SLB & M

Adapted from Geology and mineralization of the Rebel mine area, Star range, Beaver County, Utah by William B. Wray Jr. in Geology of the Milford area, 1973, p. 40.

Minerals found in the mine are galena, sphalerite, chalcopyrite, tetrahedrite, cerussite, anglesite, malachite, azurite, wulfenite, scheelite, pyrite, diopside, grossularite, tremolite, epidote, muscovite, magnetite, specular hematite, actinolite, adularia, allanite, talc, serpentine and calcite. There are no known reserves in the mine, but further exploration along the fissure zone may prove fruitful.

Red Warrior mine

The Red Warrior mine is 6 miles (9.6km) southwest of Milford and is adjacent to and just south of the Mowitza mine. The shaft collar is in NWSWNE 25-28S-12W at an elevation of 6,425 feet (1,958m). Mineralization was discovered in the early days of the camp, worked for a short time and then left idle except for an occasional shipment of ore made by lessees. In 1907, under new management, a new surface plant was installed to explore ground beneath the older workings. In 1908 regular shipments of ore were resumed. In the summer of 1910 the shaft had been sunk to the fifth level, about 450 feet (137m) below the collar (Butler, 1913, p. 199). Since that time the shaft has been considerably deepened and several thousand feet of development headings run. The property is patented and owned by the Moscow Silver Mines Co.

The mine workings are in the Devonian Guilmette Formation and underlying units (Baker, 1973, p. 34). The upper mineralization is in the top of the Guilmette immediately below the overlying Pilot Shale. Mineralization is associated with fissures that cut the limestone, strike northeast and dip steeply to the northwest. Displacements along the fissures are slight, although gouge and slickensides have been observed. Minerals in the mine are anglesite, cerussite plumbojarosite, galena, sphalerite, chalcopyrite, malachite, azurite, smithsonite, pyrite, limonite, and jarosite. There are no known reserves although low-grade ore probably remains in some parts of the mine. Exploration has a good chance of discovering overlooked ore. The substantial past production suggests a good possibility of additional ore in the area of the mine.

Mowitza Mine

The Mowitza mine is 6 miles southwest of Milford and is in the SWNENW 25-28S-12W at an elevation of 6,600 feet (2,011m). The mine is on the patented Anvil claim and has been a producer since the early days of the camp. The shaft is at least 300 feet (91m) deep and the dumps of the mine suggest that more than 2,000 feet of work has been done underground. The mine has been idle for many years and the surface plant is gone. The mine has been a substantial producer, but production records are lacking.

Mineralization is in limestone beds of the Devonian Guilmette Formation beneath the Pilot Shale (Baer, 1973, p. 34). The limestone strikes north and dips 40 degrees to the east. Northeast-southwest fissures cut the limestone and there has been some movement along them. Ore replacement has taken place at the intersections of favorable limestone beds and fissures. Minerals in the mine are anglesite, cerussite, plumbojarosite, galena, sphalerite, chalcopyrite, malachite, azurite, smithsonite, pyrite, limonite and jarosite. There are no known reserves in the mine, but exploration has a good chance of finding additional ore in the vicinity.

Cedar-Talisman Mine

The Cedar-Talisman mine is 7 miles (11.2km) west-southwest of Milford and is in NWSESE 13-28S-12W at an elevation of 6,440 feet (1,963m) above sea level. The mine originally consisted of two properties, the Cedar, owned and operated by the Cedar Mining Co. and the Talisman, owned and operated by the Majestic Copper Mining Co. In 1908 the two properties wer combined and the operating organization became known as the Cedar-Talisman Mining Co. (Salt Lake Mining Review, 1909). The mine's history is rather sketchy and is only occasionally mentioned in the Salt Lake Mining Review when sending shipments to market. The last reference came in 1916 when the mine was shipping regularly from the 800 and 900-foot levels. The mine has operated intermittently thereafter. Mine workings consist of a vertical shaft 448 feet (136m) deep from which two levels are turned. The first level contains 763 feet (232m) of drifts, crosscuts, small inclines, and two open stopes (Baetcke, 1969, p. 118). The second level contains approximately 1,585 feet (483m) of drifts, crosscuts, and a small open stope. Other workings consist of 1,220 feet (372m) of inclined shaft, small drifts, and five small stopes. The total length of mine workings is 4,973 feet (1,516m). Production records are non-existent, but the mine was primarily a zinc producer, the higher grade shipped material averaged 40 percent. It is calculated that the Cedar-Talisman mine contained approximately 15,126 tons of ore in place in the accessible stopes.

The ore deposits of the mine were bedded replacements and fissure replacements in limestones and dolomite of the Permian Callville-Pakoon Formation. The bedded replacement deposits are distinctly tabular and constitute the main ore bodies of the mine. The fissure replacement deposits are tabular, steeply dipping, and cut across the bedding of the carbonate strata. Generally they conform to the attitude of the host fissure and show limited lateral replacement of the adjacent country rock. The main bedding replacement deposits plunge N. 46° E. at 38 degrees and pitch 41 degrees to the bedding of the country rock. This deposit is confined to three limestone beds that were particularly favorable to sulfide replacement. The selective replacement of the three beds is especially apparent in the northeastern extremities of the main stope where three separate overlapping ore deposits have been exploited and developed. The fissure replacement deposits are localized in fractured zones that commonly extend great distances beyond the limits of the contained ore deposits. All of the deposits are generally tabular and quite irregular in detail. The irregular shape is indicative of incomplete sulfide replacement for the less intensely brecciated host rocks in the fissure zone. Minerals found in the mine are galena, sphalerite, cerussite, hemimorphite, smithsonite, anglesite, malachite, calcite, quartz barite, goethite, gypsum, limonite, hematite, and rhodochrosite. The mine and dumps in 1920 contained 40,000 to 50,000 tons of ore averaging 8 percent lead, 14 percent zinc, and 7 ounces of silver per ton (Heyl, 1963, p. B93). This ore was not found by Baetcke in his investigation and was probably shipped. The chances of finding ore bodies in the 10,000 to 50,000 ton range is good in the area of the mine.

Silver Bug Mine

The Silver Bug mine is 7 miles (11.2km) west-southwest of Milford and 1,100 feet (335m) south-southeast of the Cedar-Talisman mine. It is in SWSESE 13-28S-12W at an elevation of 6,560 feet (1,999m). The mine is not mentioned in the literature, but the workings consist of a shaft 100 feet (30m) deep and two prospect pits. The mine workings are in the Callville-Pakoon Formation (Baer, 1973, p. 34). Workings are aligned along an altered zone in the limestone striking N 90° W and dipping 75 degrees to the north. This zone is 1 foot (0.3m) wide and contains limonite, hematite, calcite, and possibly some lead and zinc carbonates. There are no reserves in the mine.

Vicksburg Mine

The Vicksburg mine is 5 miles (8.0km) southwest of Milford and is in NWNWSE 21-28S-12W at an elevation of 5,520 feet(1,682m) above sea level. The Vicksburg mineralization was discovered in 1872 and worked until 1877. In 1909 the Majestic Mining Co. acquired the property and sank a vertical shaft 200 feet deep near the old inclined shaft. Drifts extended only a few feet from the shaft. The mine was active between 1914 and 1916, then was idle until 1939 when the company attempted to locate the continuation of mineralization in the Incline and Central fissures (Townsend, 1950, p.3). The company drifted 500 feet on the 200 level to the northwest and southeast. Early production is presumed not to have exceeded a few hundred tons of lead and iron ore. The property is comprised of seven patented claims still owned by the New Majestic Mining Co. of Salt Lake City, Utah. In 1946 the U. S. Bureau of Mines initiated a program to examine and survey the surface and underground workings. Diamond drilling was carried out in 1948.

The mine is cut in the Permian Kaibab-Plympton Formation in gypsiferous dolomite, limestone and siltstone (Baer, 1973, p. 34). Mineralization is associated with seven fissures: Incline, Ridge, Central, Gossan, East, Contact and Copper (figure 30). Mineralization occurs along the fissures or sheeted zones in the altered limestone near or on contact with an intrusive. There are rare instances where sulfide mineralization is found in the intrusive, the north end of the Vicksburg claim serves as an example, where galena stringers up to 1 inch (2.5cm) were observed. Mineralization is of the gossan type, iron-bearing minerals replace the limestone to a maximum width of 16 feet (5m). An ocherous ore, containing 15 to 50 ounces of silver per ton and 15 to 50 percent lead, was encountered in a chimney and several tons of pure granular sulfur were found in a layer 2 to 20 inches (5-50cm) thick beneath the richest part of the ore (Butler, 1913, p. 115). Minerals in the mine are galena, sphalerite, cerussite, smithsonite, chalcopyrite, pyrite, hematite, magnetite, calcite, dolomite, quartz, and sulfur. The work of the U. S. Bureau of Mines in 1946 did not develop any new ore on the property and there are no known reserves.

Magnolia Mine

The Magnolia mine is about 8 miles (12.8km) southwest of Milford and is in SENWSE 2-29S-12W at an elevation of 5,650 feet (1,722m). Information about the mine in the literature is sparse. The Salt Lake Mining Review reported in 1908 that the Magnolia is a gold proposition and has a true fissure vein running northwest to southeast and has several tons of shipping ore on the dump. In 1925 the same publication reports that the property is developing a lead-silver carbonate ore deposit occurring in the Red Warrior Limestone. They report that the sinking of the shaft on the Magnolia lead property was stopped and prospecting was being done on the northwest-southeast fissure encountered on the 200 level. Plans were revealed to deepen the shaft to the 500-foot level and to extend drifting to intersect an ore-body encountered on the 135 and 185 levels.

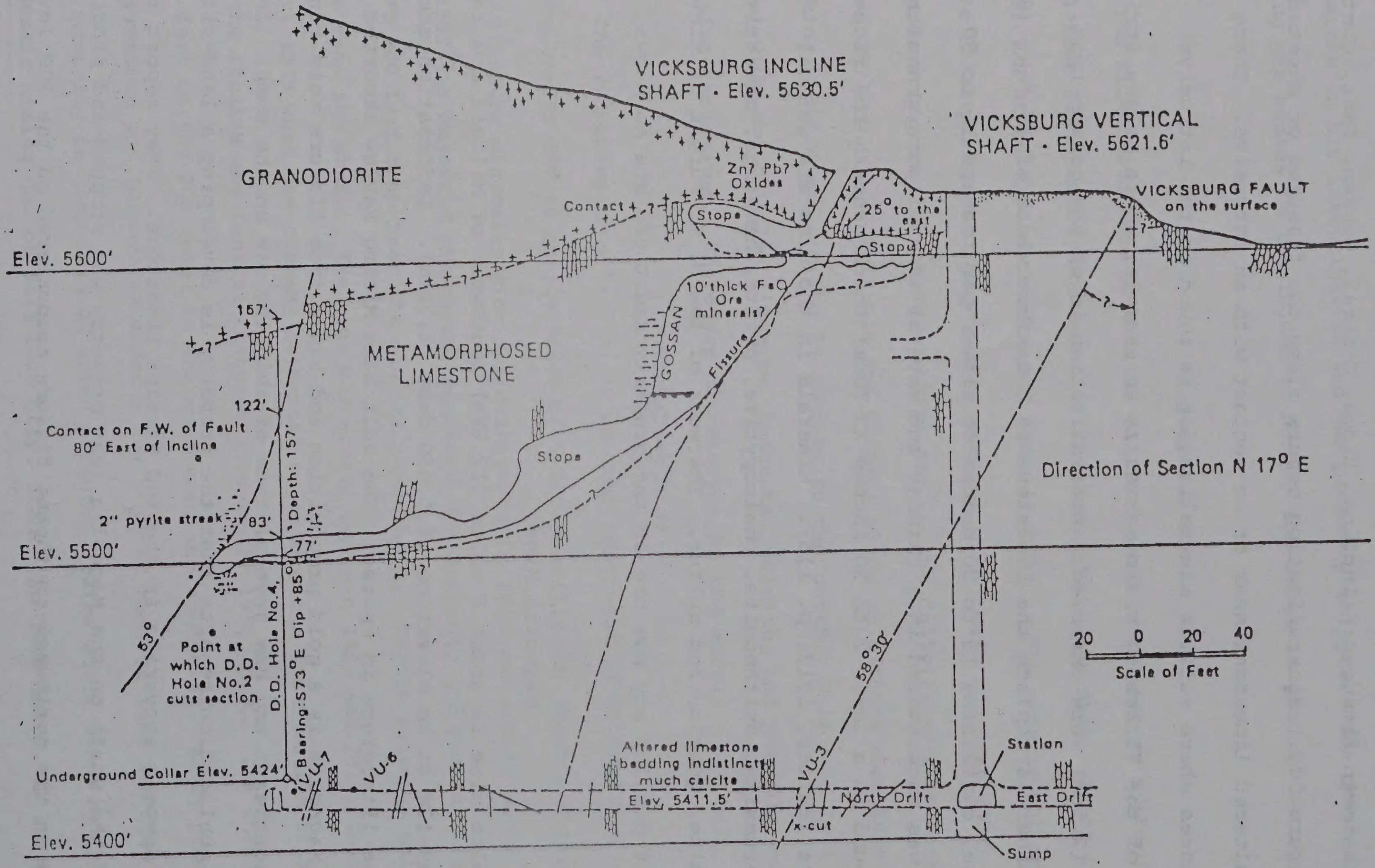

VICKSBURG INCLINE SHAFT · Elev. 5630.5'
VICKSBURG VERTICAL SHAFT · Elev. 5621.6'
GRANODIORITE
Zn? Pb? Oxides
Contact
Stope
25° to the east
Stope
VICKSBURG FAULT on the surface
Elev. 5600'
10' thick FeO Ore minerals?
157'
GOSSAN
Fissure
METAMORPHOSED LIMESTONE
122'
Contact on F.W. of Fault 80' East of Incline
Stope
Direction of Section N 17° E
2" pyrite streak
83'
Depth: 157'
77'
Elev. 5500'
53°
Point at which D.D. Hole No.2 cuts section
D.D. Hole No.4, Bearing: S73°E Dip +85°
58°30'
20 0 20 40
Scale of Feet
Underground Collar Elev. 5424'
VU-7
VU-6
Altered limestone bedding indistinct much calcite
Elev. 5411.5'
VU-3
North Drift
Station
East Drift
x-cut
Sump
Elev. 5400'

Figure 30: Longitudinal section through inclined shaft, Vicksburg mine (after Townsend, 1950).

Adapted from Geology and Mineralogy of the Milford Flat Quadrangle, Star District, Beaver County, Utah by S. Abou-Zied and J.A. Whelan, p. 15

Underground workings, as mapped in 1973, consist of a vertical shaft at least 460 feet (140m) deep from which three levels have been turned. Levels are at 117 feet, 265 feet, and 372 feet (36m, 81m, and 113m). The 117 level has 120 feet (37m) of workings and a stope. The 265 level has 495 feet (151m)of workings, two stopes, and a winze, and is the lowest level that has produced ore. The 372 level has 225 feet (69m) of drifting and a 10 foot (3m) deep winze. The total workings amount to 1,300 feet (396m). The mine is cut in the Permian Callville-Pakoon Formation. Surface workings are along a fault striking N. 70° E. and dipping 70 degrees to the east, but the ore on the 265 level is along a N. 15° E. trending structure. Several hundred tons of ore have been mined from the 117 and 265 levels. Minerals found in the mine are galena, cerussite, smithsonite, plumbojarosite, limonite, and jarosite. There are no known reserves in the mine.

Commonwealth Mine

The Commonwealth mine is 6 1/2 miles (10.1km) southwest of Milford and north of the Progressive and east of the Lady Bryan mines. It is in the SENWNE 36-28S-2W at an elevation of 6,620 feet (2,018m) above sea level. The mine was worked in the early days, but only a little ore was shipped. The mine is developed by a tunnel 1,200 feet (365m) long driven in a westerly direction. Several drifts have been run from the tunnel along favorable beds and fissures. There are shallow workings at several places on the property. The mine is owned by Stafford and Robinson of Las Vegas, Nevada and the mine has been inactive for several years.

The mine workings are in the Callville-Pakoon Formation and several igneous dikes have intruded the limestones. The limestones are also cut by fissures trending nearly east-west, northwest-southeast, and northeast-southwest. Mineralization occurs along the fissures and extends into the limestone for a short distance. Minerals in the mine are oxidized lead-zinc minerals in a gangue of limonite and calcite. There are no reserves in the mine.

Progressive Mine

The Progressive mine is 6 1/2 miles (10.4 km) southwest of Milford and lies north of the St. Marys mine. It is in SWSWNE 36-28S-12W at an elevation of 6,140 feet (1,871m) above sea level. The mine is old and worked in the early days. Production figures are unavailable but a few shipments of ore containing copper, lead, and silver values were made from the mine (Butler, 1913, p. 204). Ore replacement has taken place near the intersections of fissures with favorable limestone beds in the Callville-Pakoon Formation. Mineralization consisted of copper and lead oxide minerals in a gangue of limonite and hematite. There are no known reserves.

St. Marys Mine

The St. Marys mine is 6 1/2 miles (10.4km) southwest of Milford on the east side of Topache Peak in SESESW 36-28S-12W at an elevation of 6,300 feet (1,920m) above sea level. The mine was worked in the early days and considerable ore was taken near the surface (Butler, 1913, p. 204). The early development consisted of following the ore shoots from the surface to a depth where the extraction of ore ceased to be profitable. The principal output was lead, silver, and iron flux ore carrying small amounts of other metals, some copper ore was mined and shipped. Mine workings consist of three vertical shafts, one adit, two inclines, and some glory holing. The property is patented and owned by Charles L. Alexander of North Dakota.

The mine is in the Callville-Pakoon Formation in limestones, dolomites, and occasional beds of sandstone or orthoquartzite. The orebodies are associated with east-west fissures, certain beds of limestone have been replaced along them for short distances, forming chimney-like masses of ore. The lead-silver ore is oxidized at the surface, but in some of the deeper workings galena was found. Ore minerals in the mine are cerussite, malachite, chalcopyrite, and bismuthinite in a gangue of limonite, goethite, pyrite, garnet, muscovite, and calcite. There are no known reserves in the mine.

Maud S Mine

The Maud S mine is 5 1/2 miles (8.8km) southwest of Milford in the NENWSW 21-28S-11W at an elevation of 5,530 feet (1,685m). Workings on the property consist of two shafts, one 275 feet (84m) and the other 80 feet deep (84m and 24m), and a prospect pit (Abou-Zied and Whelan, 1973, p. 16). No production records are available but Salt Lake Mining Review reports indicate that several carloads were shipped, some running 30 to 50 percent lead, 2 1/2 ounces of silver to the ton and about $20 in gold to the ton (1927). The property is unpatented and held by location by Maud S. Ferguson of Salt Lake City, Utah. The workings are cut in the Kaibab-Plympton and Toroweap Formations consisting of gypsiferous dolomite, limestone, siltstone, and sandstone. Mineralization is associated with the nearby intrusive. Minerals on the dump are cerussite, chalcopyrite, smithsonite, limonite, and hematite. A sample from the dump assayed 2.1 ounces of silver per ton, a trace of gold, no lead, 0.6 percent zinc, and no copper. There are no reserves in the mine.

Estelle (Estella)Mine

The Estelle mine is located 5 1/2 miles (8.8 km) southwest of Milford in SESWSW 21-28S-11W at an elevation of 5,460 feet (1,664m). The mine is known to have been active 1900-1910, at one time there was a mill handling 15 to 20 tons of ore per day. Mine workings consist of two shafts and two adits. The main adit has approximately 650 feet (198m) of drifting and the other is 80 feet (24m) long (figure 31). The main shaft is 200 feet (61m) deep and total workings on the property amount to 1,800 feet (549m). The property was controlled by the Estelle Gold Mining Co. in the early days and is currently held by Dotson and Holly of Milford, Utah.

Exposed rocks include intrusives and units of the Kaibab-Plympton and Toroweap Formations. The mineralization is associated with the contact of the intrusive and the sediments. Mineralization occurs in four distinct veins, three carrying gold, and the other copper and other metals. Minerals include

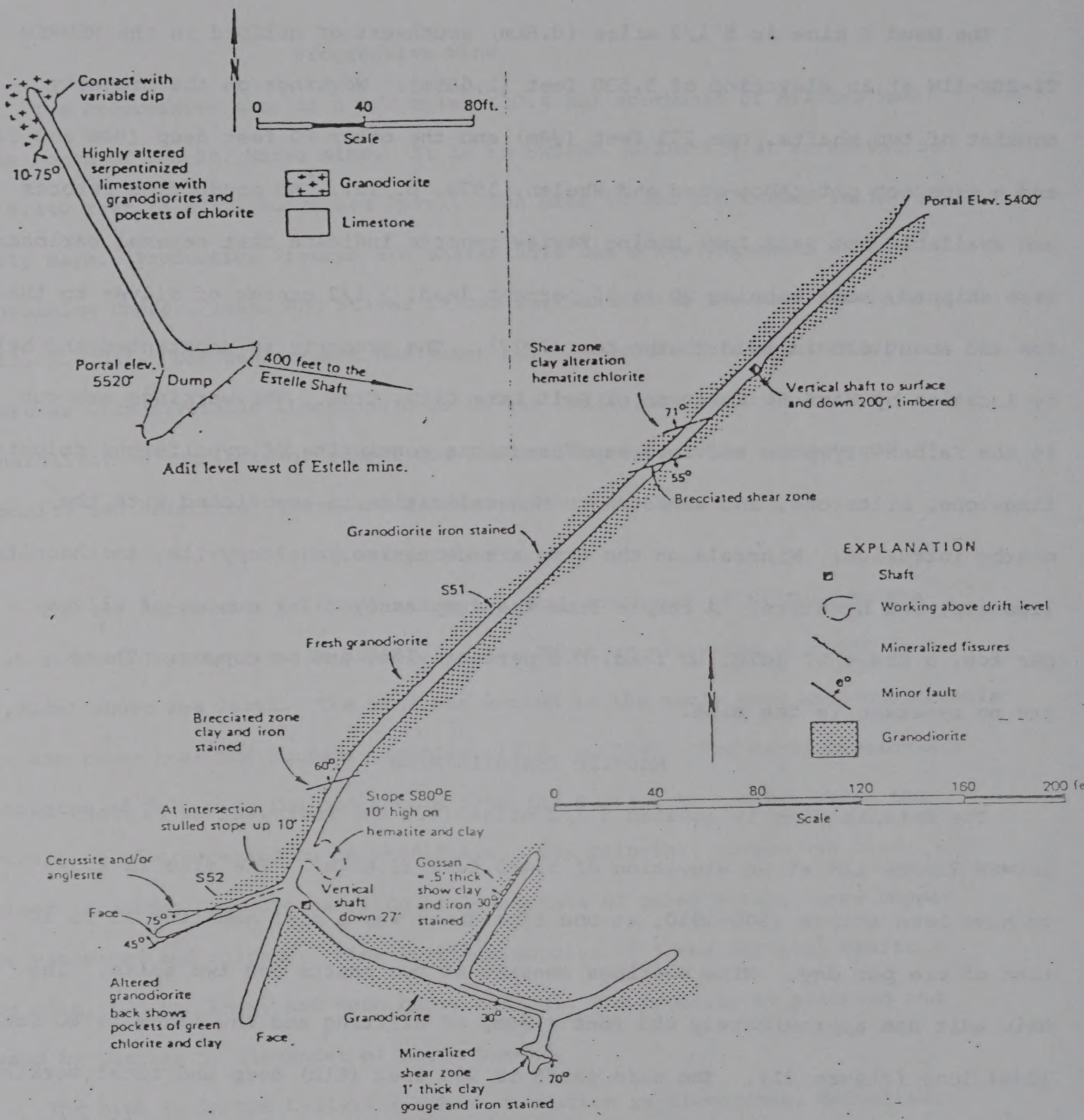

Contact with variable dip
10-75°
Highly altered serpentinized limestone with granodiorites and pockets of chlorite
N
0
40
80ft.
Scale
Granodiorite
Limestone
Portal elev. 5520'
Dump
400 feet to the Estelle Shaft
Adit level west of Estelle mine.
Portal Elev. 5400'
Shear zone clay alteration hematite chlorite
Vertical shaft to surface and down 200', timbered
71°
55°
Brecciated shear zone
Granodiorite iron stained
EXPLANATION
Shaft
Working above drift level
Mineralized fissures
Minor fault
Granodiorite
S51
Fresh granodiorite
N
Brecciated zone clay and iron stained
60°
0
40
80
120
160
200 feet
Scale
At intersection stulled stope up 10'
Stope S80°E 10' high on hematite and clay
Cerussite and/or anglesite
S52
Gossan = .5' thick show clay and iron stained
30°
Vertical shaft down 27'
Face
75°
45°
Altered granodiorite back shows pockets of green chlorite and clay
Face
Granodiorite
30°
Mineralized shear zone 1' thick clay gouge and iron stained
70°

Figure 31: Underground plan view of the adit level of Estelle mine.

Adapted from Geology and Mineralogy of the Milford Flat Quadrangle, Star District, Beaver County, Utah by S. Abou-Zied and J.A. Whelan, p. 18&19.

cerussite, anglesite, native gold, malachite, limonite, hematite, chlorite, sericite, and kaolinite. The host rock has been strongly serpentinized near the ore, is generally bleached and has pockets of chloride. There are no known reserves in the mine.

Gold Crown (Gold Crown Extension) Mine

The Gold Crown or Gold Crown Extension mine is 6 miles southwest of Milford in the SESENE 29-28S-11W at an elevation of 5,920 feet (1,804m). Information about the mine and its activity comes from various issues of the Salt Lake Mining Review which reports that the workings included a shaft 230 feet (70m) deep and that at least 9 carloads of ore were shipped from the 300-foot level. This would indicate the shaft had been deepened at least to the 300-foot level. The ore ran 45 ounces of silver to the ton and contained 20 to 25 percent lead. Through 1923, $25,000 worth of ore was mined from the property. Mining activity extended at least from 1910 to 1923.

The mine workings are in the Permian Talisman Quartzite. Oxide lead, zinc, copper, silver, and gold ore is associated with northeast-striking fissures in the quartzite. Minerals observed on the dump are anglesite, cerussite, malachite, smithsonite, hematite, limonite, pyrite, and goethite (Abou-Zied and Whelan, 1973, p. 17). There are no reserves in the mine.

Woodhouse Mine

The Woodhouse Mine is located 5 miles (8km) southwest of Milford in NWNWNE 28-28S-11W at an altitude of 5,320 feet (1,622m). Early reports show that the vein on the property assayed up to $6,000 in gold and 150 ounces in silver to the ton. A 40-ton carload averaging about $200 a ton was shipped in 1912 (Salt Lake Mining Review, Aug. 15, p. 31). Mine workings consist of two vertical shafts about 150 feet (46m) apart on a vein striking N. 65° E. and dipping 60 degrees southeasterly. At the shaft collar the vein is 1 1/2 feet (0.45 m) wide. Minerals on the dump are pyrite, hematite, limonite, cerussite, quartz, and chalcedony. The mine is cut in gypsiferous dolomite, limestone, siltstone, and gypsum of the Kaibab-Plympton and Toroweap Formations. The mineralization is associated with the contact of the sediments with the nearby intrusive rock. There are no reserves in the mine.

Sundown Mine

The Sundown mine is 4 1/2 miles (6.8km) southwest of Milford and is in SENWNW 22-28S-11W at an altitude of 5,245 feet (1,599m). Mine workings consist of an adit and a shaft (figure 32). The adit contains about 500 feet (152m) of drifting and the shaft is 25 feet (8m) deep. Total workings amount to 550 feet (168m). The mine is cut in the Permian Kaibab Formation and in intrusive rocks that crop out at the surface (Abou-Zied and Whelan, 1973, p. 19). Mineralization is in veins occupying faults. A mineralized vein near the portal of the adit is 0.5 to 1 foot wide (15-20cm) and strikes N. 22° W. and dips 57 degrees southwesterly. Minerals identified in the veins are cerussite, hemimorphite, aurichalcite, limonite, hematite, kaolinite, calcite, and quartz. There are no reserves in the mine.

Atlas Mine

The Atlas mine is 6 miles (9.9km) southwest of Milford and is east of the Commonwealth mine. It is in NWNENE 36-28S-12W at an elevation of 6,040 feet (1,841m) above sea level. The property includes a shaft, at least 200 feet (61m) deep, from which at least two levels have been turned. The dump suggests several hundred feet of drifting and crosscutting. There are several small adits on the property, which is patented and owned by Hazel D. Johnson of Texas. The mine has been abandoned for many years. Mineralization is along east-west fissure systems in limestone of the Callville-Pakoon Formation. It is mainly of copper with some shows of lead. The ore contains malachite, azurite, and cerussite in a gangue of limonite, goethite, quartz and calcite. There are no reserves in the mine.

Mammoth Lode Mine

The Mammoth Lode mine is 10 miles (16km) southwest of Milford in NENENW

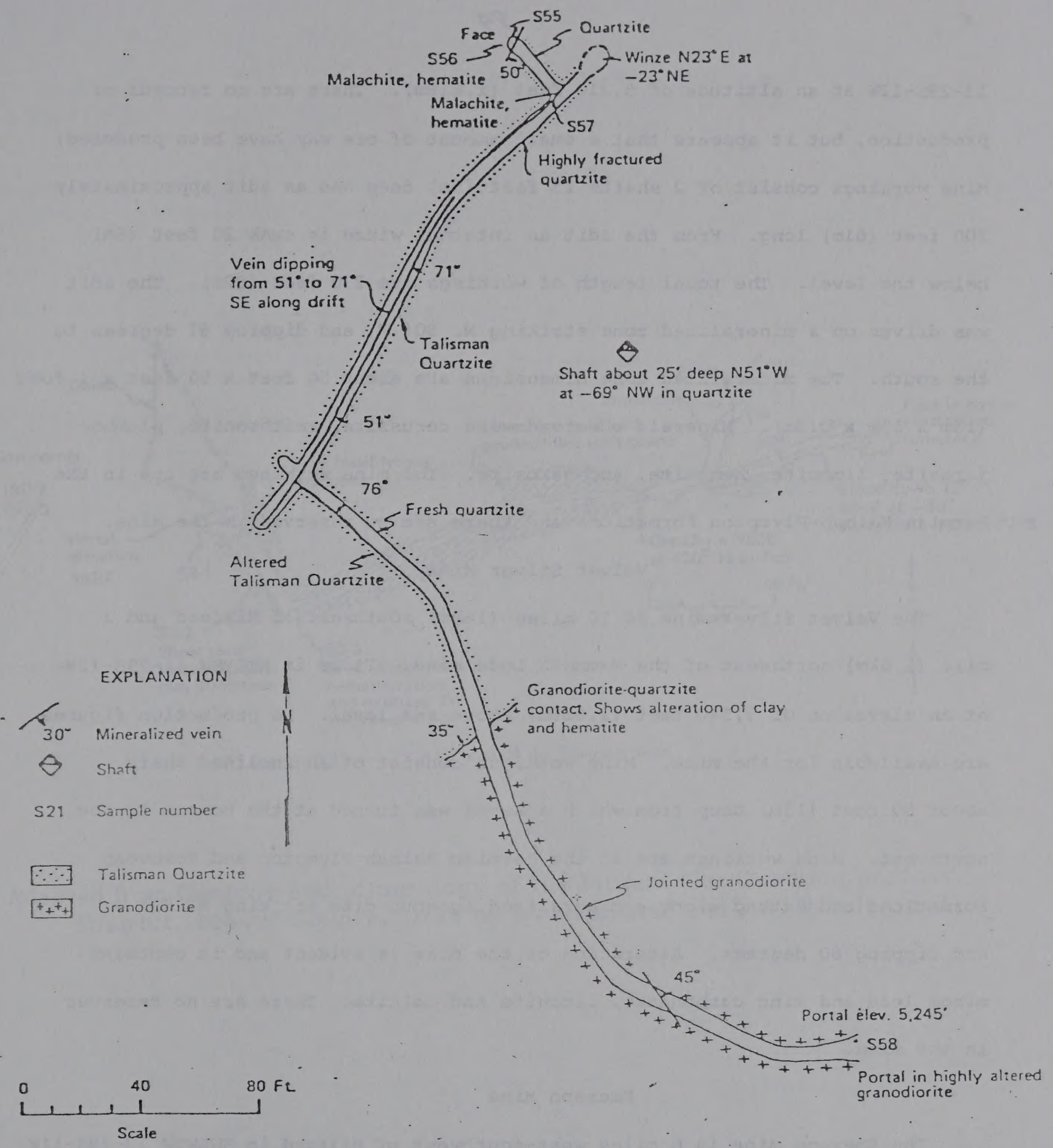


Figure 32: Underground plan of the adit level of the Sundown mine.

Adapted from Geology and Mineralogy of the Milford Flat Quadrangle Star District, Beaver County, Utah by S. Abou-Zied and J.A. Whelan, p. 20

Description and X-ray fluorescence analyses of samples from the Sundown mine (sample locations shown on figure 7).

Sample no.	Description	X-ray fluorescence (ppm)					
		Silver	Lead	Zinc	Copper	Manganese	Arsenic
S55	Talisman Quartzite chip	—	—	—	—	—	—
S56	Channel-vein	Nd	8,155	491	Tr	4,385	Nd
S57	Channel-vein	Nd	3,512	995	33,115	1,000	Nd
S58	Granodiorite	—	—	—	—	—	—

13-29S-12W at an altitude of 5,310 feet (1,618m). There are no records of production, but it appears that a small amount of ore may have been produced. Mine workings consist of 2 shafts 15 feet (5m) deep and an adit approximately 200 feet (61m) long. From the adit an internal winze is sunk 20 feet (6m) below the level. The total length of workings are 270 feet (82m). The adit was driven on a mineralized zone striking N. 90° W. and dipping 82 degrees to the south. The mineralized zone dimensions are about 50 feet x 50 feet x 1 foot (15m x 15m x 0.3m). Minerals observed were cerussite, smithsonite, plumbojarosite, limonite, hematite, and jarosite. The mine workings are cut in the Permian Kaibab-Plympton Formations and there are no reserves in the mine.

Velvet Silver Mine

The Velvet Silver mine is 10 miles (16km) southwest of Milford and 1 mile (1.6km) northwest of the Mammoth Lode mine. It is in NESESW 11-29S-12W at an elevation of 5,540 feet (1,689m) above sea level. No production figures are available for the mine. Mine workings consist of an inclined shaft about 50 feet (15m) deep from which a level was turned at the bottom to the northwest. Mine workings are in the Permian Kaibab-Plympton and Toroweap Formations and extend along a mineralized igneous dike striking N. 60° W. and dipping 80 degrees. Alteration of the dike is evident and it contains minor lead and zinc carbonates, limonite and calcite. There are no reserves in the mine.

Emerson Mine

The Emerson mine is 6 miles west-southwest of Milford in SWSWSW 17-28S-11W at an elevation of 5,920 feet (1,804m). Examination of the underground workings suggest that a small amount of ore was shipped from the mine. The workings consist of an adit driven southeast until a fault was intersected, then turned northeast to follow the structure for about 190 feet (58m). Stoping has taken place along the brecciated shear zone above the drift and a shaft from the surface connects with the adit 160 feet (49m) from the portal (figure 33).

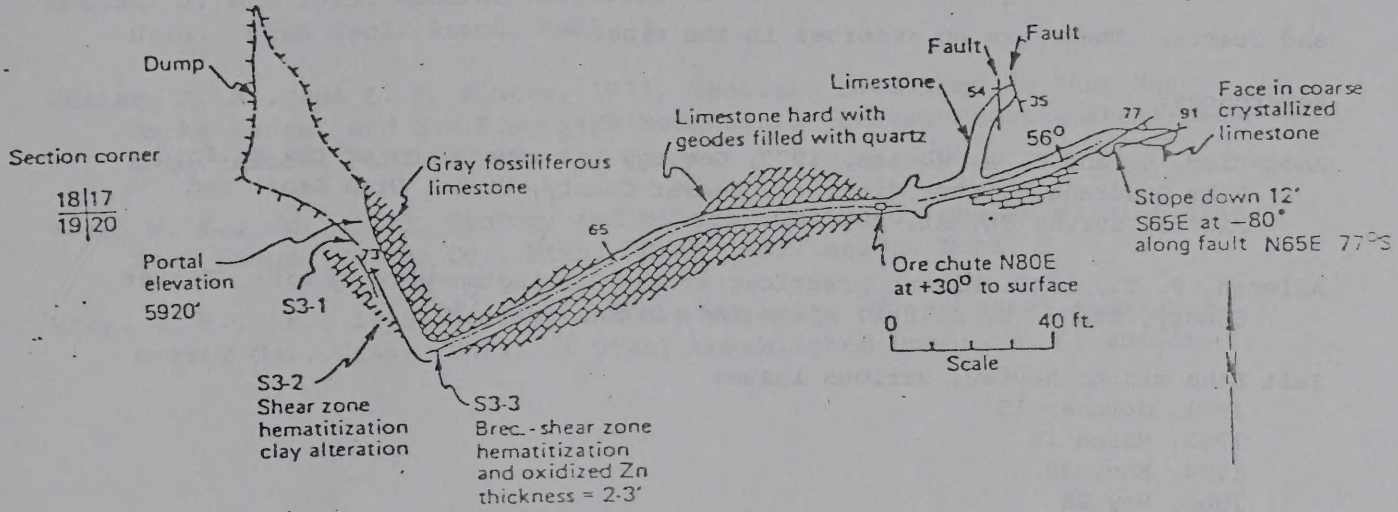


Figure 33: Adit level of the Emerson mine.

Adapted from Geology and Mineralogy of the Milford Flat Quadrangle, Star District, Beaver County, Utah by S. Abou-Zied and J.A. Whelan p.21

The shaft is 50 feet (15m) deep and the adit is 355 feet (108m) long. The workings have a total length of 430 feet (131m). The mine is cut in the Permian Kaibab Limestone, the mineralized brecciated shear zone strikes N. 75° E. and dips 65 degrees northwesterly. A sample taken along the zone assayed 1 percent lead, 2 percent zinc with a trace of silver. Minerals identified in the mine are cerussite, hemimorphite, aurichalcite, limonite, hematite, kaolinite, calcite, and quartz. There are no reserves in the mine.

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BOX ELDER COUNTY

Box Elder County has been an important producer of lead and zinc in the past, presently there are no active mines. These metals were produced together with gold, silver, and copper. Through 1976 it is estimated that at least 7,820,000 pounds of lead and 7,302,000 pounds of zinc were produced in the county. The value at time of production amounts to $547,407 for lead and $876,213 for zinc. At today's prices (January, 1977) the same amount of lead would be worth more than 2.1 million dollars and the zinc more than 2.7 million dollars.

Six mining districts were examined and are listed in order of importance as to lead and zinc: Promontory, Lucin, Park Valley, Ashbrook, Rosebud, and Box Elder. Those districts having the most promise for future production of lead and zinc are Promontory and Lucin. The county and its districts are located on figure 34 and production is summarized in table 15.

Box Elder District

The Box Elder district is located on Wellsville Mountain approximately three miles north-northeast of Brigham City (figures 35 and 36). The district is not easily accessible as only one road reaches the lower part on the west side of the mountain, the remainder of the district can be reached only by foot or horseback. The Box Elder district was organized October 2, 1899 and is of minor importance, very little production has been realized from it. There are no available production figures, but it is estimated that no more than a thousand tons of ore have been produced containing lead, zinc, copper, gold, and antimony. The only lead-zinc mine in the district is the Baker mine, located near the head of Baker Canyon.

Rock formations in the district range from the Cambrian Brigham Quartzite to the Mississippian Brazer Formation. The Cambrian section, 3,075 feet (937m) thick, consists of a basal quartzite overlain with a limestone-shale sequence.

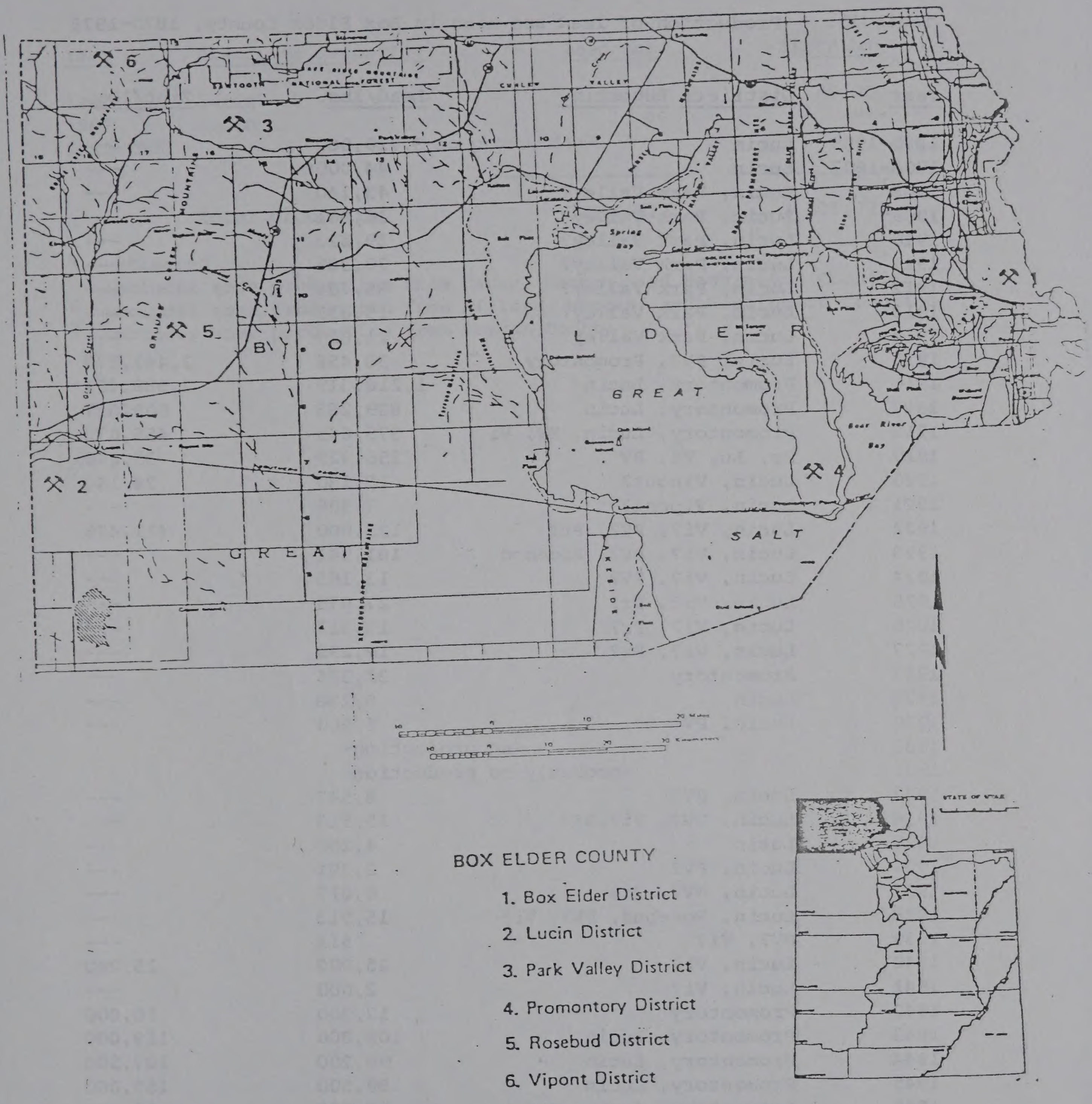


Figure 34: Mining districts of Box Elder County

Table 15: Production of lead and zinc in Box Elder County, 1870-1975

Year	Districts Reporting	Lead/lbs.	Zinc/lbs.
1870-1905	Lucin	3,720,000	---
1906-1907	Lucin	44,000*	---
1908[1]	Lucin, Park Valley?	43,140	---
1909[2]	Lucin, Park Valley?	26,961	---
1910[3]	Lucin, Park Valley?	39,623	---
1911	Lucin, Park Valley?	70,385	---
1912	Lucin, Park Valley?	85,734	---
1913	Lucin, Park Valley?	15,832	---
1914	Lucin, Park Valley?	21,827	---
1915	Lucin, PV?, Promontory	38,458	2,482,578
1916	Promontory, Lucin	1,218,319	2,688,401
1917	Promontory, Lucin	839,283	609,037
1918	Promontory, Lucin, PV, Vi	375,645	455,673
1919	Pr, Lu, Vi, PV	256,729	35,666
1920	Lucin, Vipont?	18,130	24,140
1921	Lucin, Vipont?	7,306	---
1922	Lucin, Vi?, PV?, Pr?	123,000	411,476
1923	Lucin, Vi?, PV?, Rosebud	181,941	---
1924	Lucin, Vi?, PV?	13,165	---
1925	Lucin, Vi?, Pr?	27,075	---
1926	Lucin, Vi?, Pr?	13,317	---
1927	Lucin, Vi?, Pr?	19,292	---
1928	Promontory	31,385	---
1929	Lucin	8,238	---
1930	Lucin, PV?	5,960	---
1931		-no production-	
1932		-probably no production-	
1933	Lucin, PV?	8,547	---
1934	Lucin, PV?, Vi?,BE?	15,513	---
1935	Lucin	4,200	---
1936	Lucin, PV?	2,391	---
1937	Lucin, PV?, Vi?	6,017	---
1938	Lucin, Rosebud, PV?, Vi?	15,913	---
1939	PV?, Vi?	511	---
1940	Lucin, Vi?	25,000	15,000
1941	Lucin, Vi?	2,000	---
1942	Promontory	17,300	16,000
1943	Promontory, Lucin	109,800	119,000
1944	Promontory, Lucin	90,200	107,500
1945	Promontory, Lucin	89,500	155,000
1946	Promontory, Lucin, PV?	68,000	90,000
1947	Promontory, Lucin, PV?	18,500	29,800
1948	Lucin	42,500	---
1949	Lucin	12,500	---
1950-1951		-no production-	
1952	Promontory	18,000	14,000
1953-1954		-no production-	
1955	Lucin, BE?, Vi?	6,000	2,000
1956	Lucin, Promontory	600	500
1957		-no production-	
1958	Lucin?	2,000	---
1959-1960		-no production-	

Table 15 continued

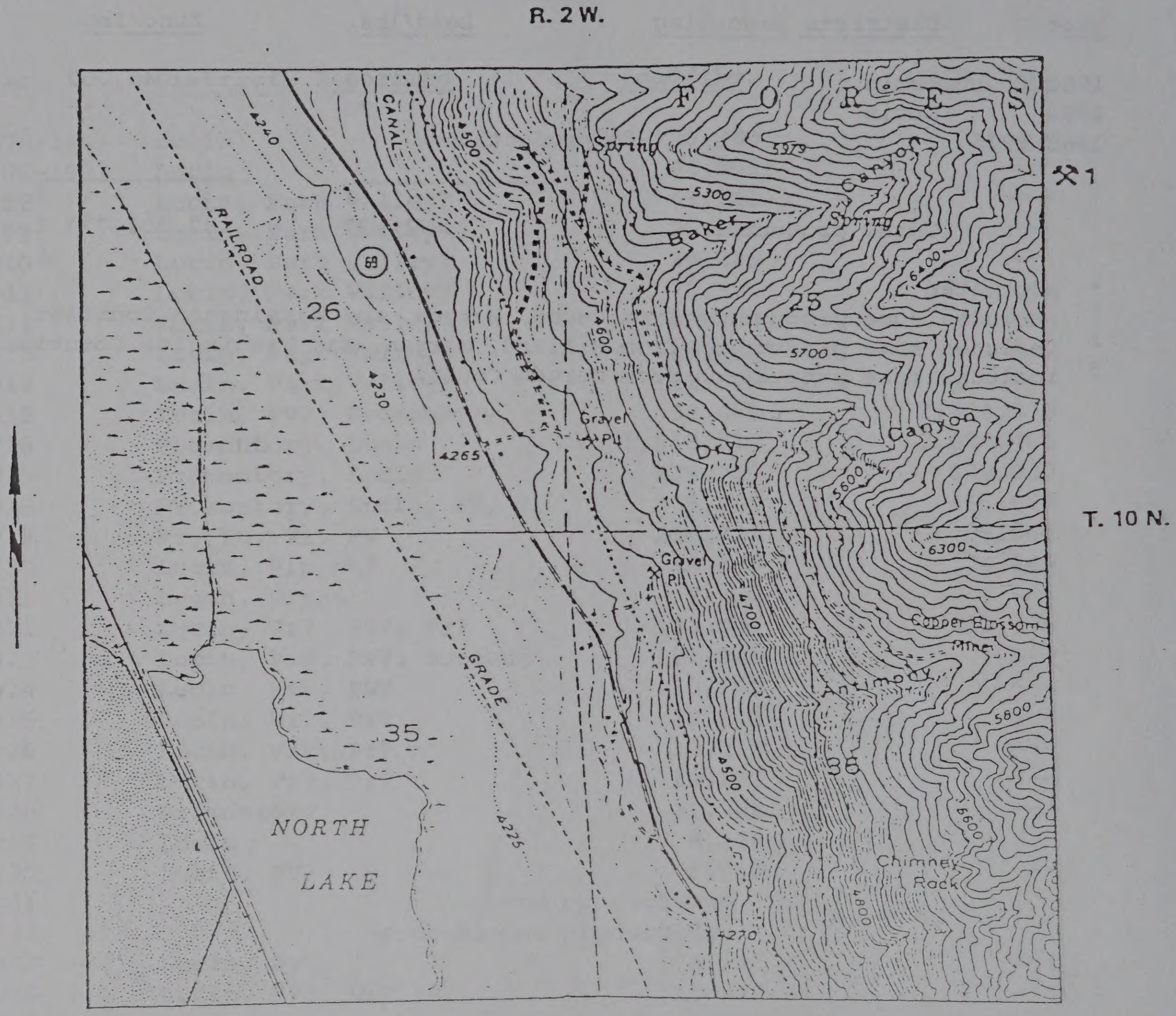
Year	Districts Reporting	Lead/lbs.	Zinc/lbs.
1961	Lucin	22,000	46,000
1962	Lucin	90	---
1963-1975	-no production-		
	Total production	7,821,827	7,301,771

* estimated

1 includes some production from Cache, Morgan, and Washington Counties

2 includes some production from Millard, Morgan, and Washington Counties

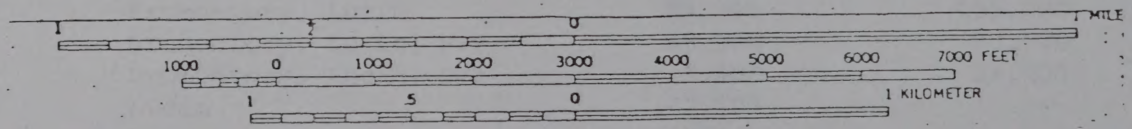
3 includes some production from Morgan County



BOX ELDER DISTRICT

1. Baker mine

Figure 35: Topographic map of Box Elder mining district



Adapted From: USGS Brigham City 7½′ Quadrangle

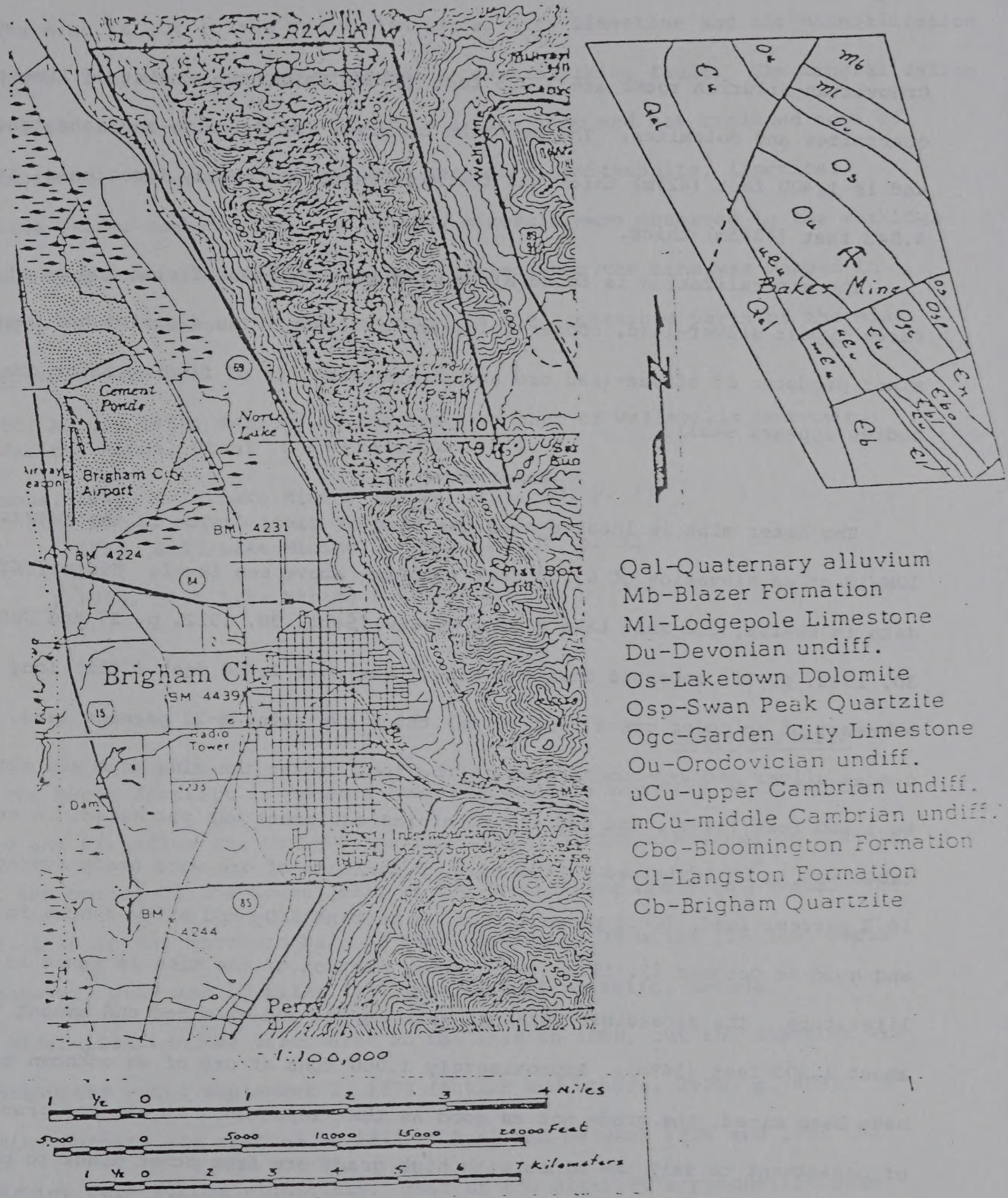


Figure 36:

LOCATION AND GEOLOGIC MAP OF
BOX ELDER MINING DISTRICT
Geology adapted from Geologic Atlas of Utah, Cache County by J.S. Williams
1958, map 6.
Base map USGS Great Salt Lake and Vicinity, 1964, 1:125,000

Ordovician-Silurian rocks are 2,225 feet (678m) thick and consist of limestones, quartzites and dolomites. The Devonian consists of dolomite and sandstone and is 1,400 feet (427m) thick and the Mississippian, mostly limestones, is 4,543 feet (1385m) thick.

The mineralization is found along northeast trending faults and is of three types: silver-lead, copper-gold, and antimony. The district has been a minor producer of silver-lead ore and the possibility of finding major ore bodies appears small.

Baker Mine

The Baker mine is located near the head of Baker Canyon in the SWSWNW30-10N-1W at an elevation of 6,700 feet (2,042m) above sea level. Historical data is sparse, the Salt Lake Mining Review (Sept. 30, 1912, p. 27 and June 30, 1913, p. 31) reported that the tunnel was over 2,400 feet (732m) long with a breast of shipping ore 4 feet (1.2m) thick averaging 8-22 percent lead, 4 ounces silver and 2-3 ounces gold to the ton. Later the mine tram was extended to 1,800 feet (549m), and additional mining equipment was purchased. A new cable was to be installed on the tram, 5 carloads of ore were ready averaging 18.3 percent lead, 20-22 percent iron, 9 percent SiO_2 and a few ounces in silver and gold on October 15, 1914. No further mention of the mine is found in the literature. The accessible workings were mapped and examined and amount to about 1,800 feet (549m). Approximately 1,000 tons of ore of an unknown grade have been mined, the grade not as good as that reported. It was the practice of management to salt the mines with high grade ore from other mines to promote the sale of stock (oral communication, Mr. Gibbs, 1973). The workings consist of an adit and one stope and are producing 5-10 gallons of water per minute. The mine was serviced by a mule trail leading from the valley floor and an aerial tram that hauled supplies to the mine and ore on the return trip. The tram is dismantled and only an occasional tram bucket remains on the mountain side.

The mine is cut in the Ordovician Garden City Limestone and the mineralization is found in a breccia along a northeast to east-striking fault. The mineralization consists of silver-lead ore containing a little zinc and has replaced some of the limestone. Minerals observed were cerussite, smithsonite, limonite, manganese oxides and calcite. No primary minerals were observed in the workings. The main stope was inaccessible and not sampled when the mine was mapped in November, 1973. No reserve ore was noted in the accessible parts of the mine.

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Lucin District

The Lucin district is located along the western boundary of Box Elder County and straddles the Utah-Nevada line. Most of the mines are on the Utah side, the portal of the lowest adit of the Tecoma mine opens in Nevada. The district is in the northern half of the Pilot Range 35 miles (56.3km) north of Wendover, Utah and 12 miles (19.3 km) east of Montello, Nevada.

Mineralization was discovered in the area in 1868, but the district was not organized until September 2, 1872 (Butler and others, 1920, p. 489). A smelting furnace was erected in 1871 at Buel and between 1886 and 1894 the properties were worked vigorously. Most of the district's production came prior to 1917. The total reported production for the district includes 5.9 million pounds of lead, 0.6 million pounds of zinc, 18.2 million pounds of copper, over 262,000 ounces of silver, and 248 ounces of gold. The total value of this production is projected to be between 3.8 and 4.5 million dollars

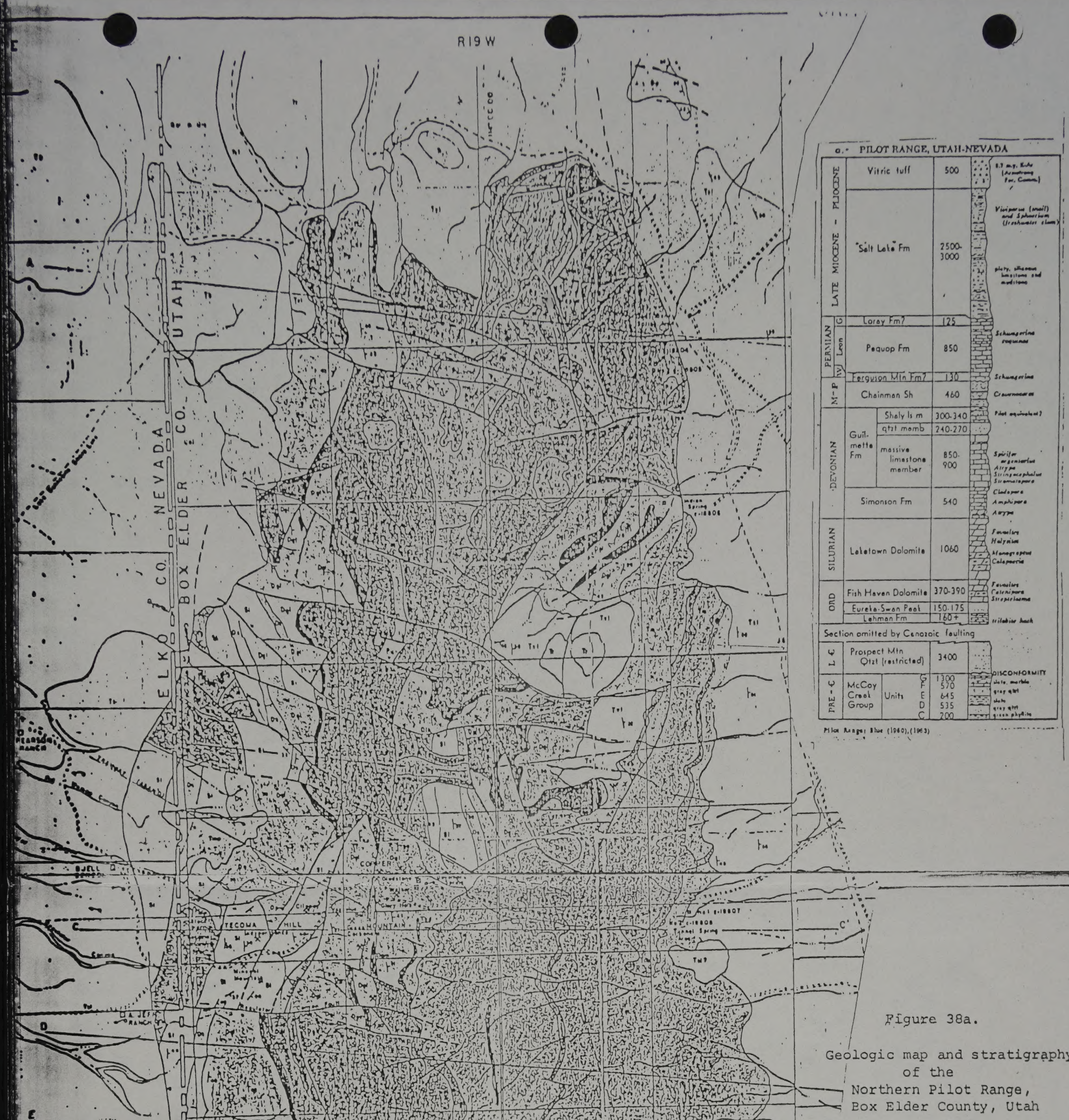
(Doelling, 1972, p. 36). The most important lead and zinc mines of the district are those of Tecoma Hill and the mines located at elevations beneath the Glory holes of Copper Mountain, the center point. These and other mines are located on figure 37.

Sedimentary rocks exposed in the district range from the Precambrian Prospect Mountain Quartzite to the Permo-Pennsylvanian "post-Leonard" formation (Blue, 1960, pl. 2). Igneous rocks consist of a Tertiary intrusive monzonite porphyry and various extrusive units (see geologic map, figure 38a). The general dip of the sediments is to the east and numerous east-west and north-south trending faults cut the strata. Mineralization consists of replacements and fracture fillings in favorable limestone and dolomite beds of Ordovician, Silurian, and Devonian age (Doelling, 1972, p. 36). The faults and selective beds in the carbonate sequence are the controlling features of the ore bodies. Faulting has facilitated the migration of the ore-bearing solutions. The principal lead and zinc ore bodies are in the Tecoma Hill area; they are small, and in addition to lead and zinc, contain copper, silver and minor gold and iron. Iron has been produced from the Copper Mountain area. Minerals noted in the lead-zinc mineralizations include anglesite, cerussite, wulfenite, smithsonite, hemimorphite, plumbojarosite, native gold, native silver, galena, sphalerite, chalcopyrite, limonite, goethite, hematite, alunite, halloysite, sericite, kaolinite and calcite.

The district contains substantial reserves of oxidized zinc ores and zinc-bearing material (Heyl, 1963, p. B37). This mineral remains in the mines and on the dumps. The chance for discovering and developing additional lead and zinc reserves in the vicinity of the old workings and along the known geologic structures is good.

Tecoma Mine

The Tecoma mine is on the western side of the Pilot Range on the west end of what is known as Tecoma Hill. It is in the southern half of section 8,



a. PILOT RANGE, UTAH-NEVADA

LATE MIOCENE - PLIOCENE	Vitric tuff		500	8.3 m.y. K-Ar (Armstrong Per. Comm.)
LATE MIOCENE - PLIOCENE	"Salt Lake" Fm		2500-3000	Viviparus (snail) and Sphaerium (freshwater clam) platy, siliceous limestone and mudstone
PERMIAN G	Loray Fm?		125	
PERMIAN Leon	Pequop Fm		850	Schwagerina coquinas
PERMIAN W	Ferguson Mtn Fm?		130	Schwagerina
M-P	Chainman Sh		460	Cravenoceras
DEVONIAN	Guilmette Fm	Shaly ls m	300-340	Pilot equivalent?
		qtzt memb	240-270	
		massive limestone member	850-900	Spirifer argentarius Atrypa Stringocephalus Stromatopora
	Simonson Fm		540	Cladopora Amphipora Atrypa
SILURIAN	Laketown Dolomite		1060	Favosites Halysites Monograptus Calapoecia
ORD	Fish Haven Dolomite		370-390	Favosites Catenipora Streptelasma
	Eureka-Swan Peak		150-175	
	Lehman Fm		160+	trilobite hash
Section omitted by Cenozoic faulting				
L Є	Prospect Mtn Qtzt (restricted)		3400	DISCONFORMITY
PRE-Є	McCoy Creek Group	Units G	1300	slate, marble
		F	570	gray qtzt
		E	645	slate
		D	535	gray qtzt
		C	200	green phyllite

Pilot Range: Blue (1960), (1963)

Figure 38a.

Geologic map and stratigraphy
of the
Northern Pilot Range,
Box Elder County, Utah

after Blue, 1960 and Hintze,
1973, p. 120

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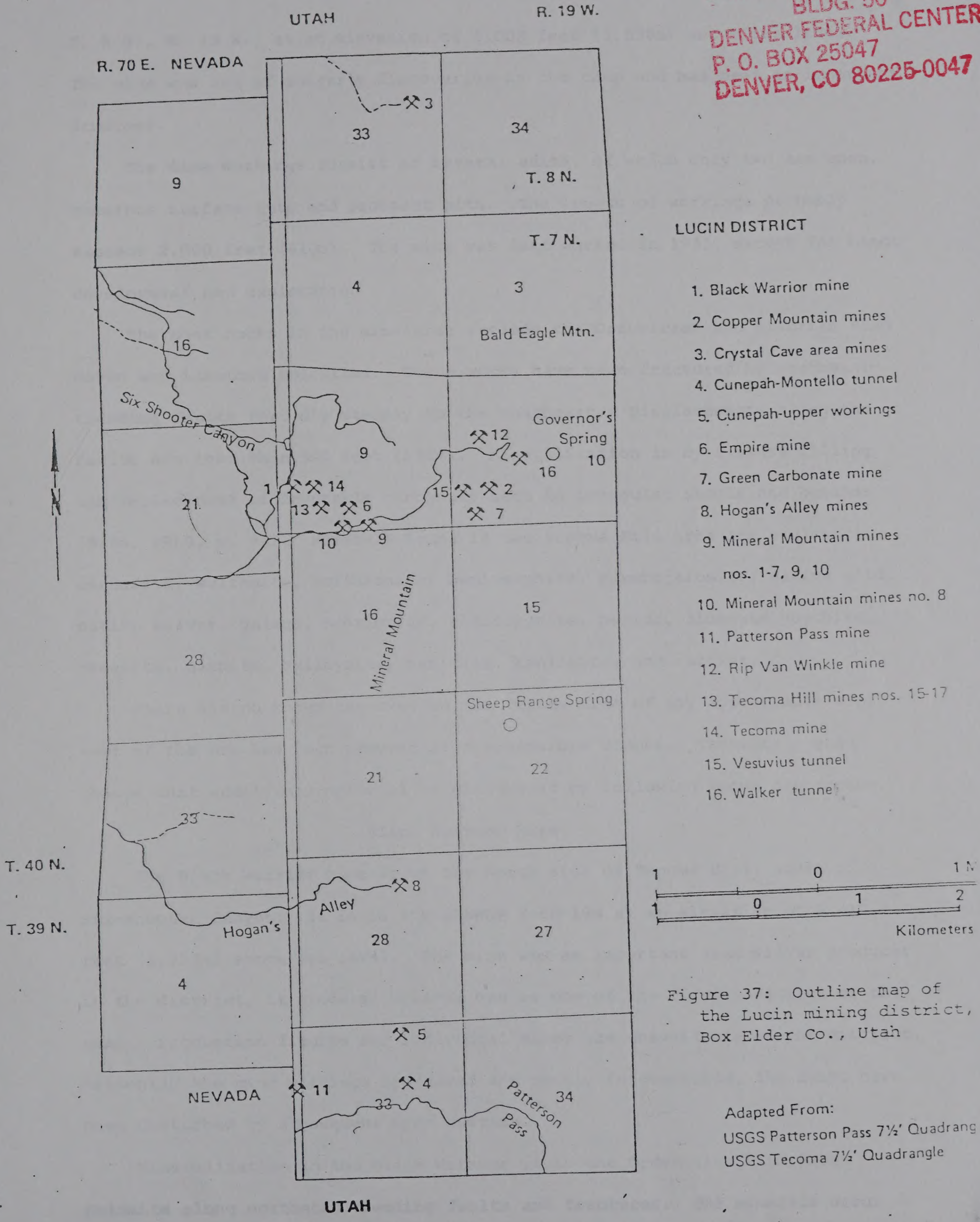


Figure 37: Outline map of the Lucin mining district, Box Elder Co., Utah

Adapted From:
USGS Patterson Pass 7½' Quadrang
USGS Tecoma 7½' Quadrangle

T. 6 N., R. 19 W., at an elevation of 6,003 feet (1,830m) above sea level. The mine was one of the early discoveries in the camp and has been an important producer.

The mine workings consist of several adits, of which only two are open, numerous surface cuts and prospect pits. The length of workings probably exceeds 2,000 feet (610m). The mine was last worked in 1943, except for minor development and exploration.

The host rocks in the mine area include the Ordovician and Silurian Fish Haven and Laketown Dolomites. These rocks have been fractured by northeast-trending faults that dip steeply to the southeast. Displacements along the faults are less than 500 feet (152m). Mineralization is by fissure filling and replacement of favorable carbonate beds in irregular shoots and bunches (Blue, 1960, p. 94). Minerals found in the Tecoma Hill area are anglesite, cerussite, wulfenite, smithsonite, hemimorphite, plumbojarosite, native gold, native silver, galena, sphalerite, chalcopyrite, pyrite, limonite goethite, hematite, alunite, halloysite, sericite, kaolinite, and calcite.

There are no known reserves in the Tecoma mine of any appreciable size. Most of the ore has been removed from accessible stopes. There is a good chance that additional ore will be discovered by following known ore trends.

Black Warrior Mine

The Black Warrior mine is on the north side of Tecoma Hill, south of Six-shooter Canyon. It is in the SENWNW 9-6N-19W at an elevation of 6,410 feet (1,953m) above sea level. The mine was an important lead-silver producer in the district, it produced bonanza ore as one of the first locations of the camp. Production figures for individual mines are unavailable in the district. Presently the mine workings are caved and mostly inaccessible, the dumps have been disturbed by subsequent open cutting.

Mineralization in the Black Warrior is in the Ordovician Fish Haven Dolomite along northeast trending faults and fractures. The minerals occur as fissure fillings and as replacements of favorable dolomite beds. They include anglesite, cerussite, wulfenite, smithsonite, hemimorphite, plumbojarosite, native gold, native silver, galena, sphalerite, chalcopyrite, pyrite, limonite, hematite, goethite, alunite, halloysite, sericite, kaolinite, and calcite. There are no known reserves in the mine.

Tecoma Hill Mines 15, 16, and 17

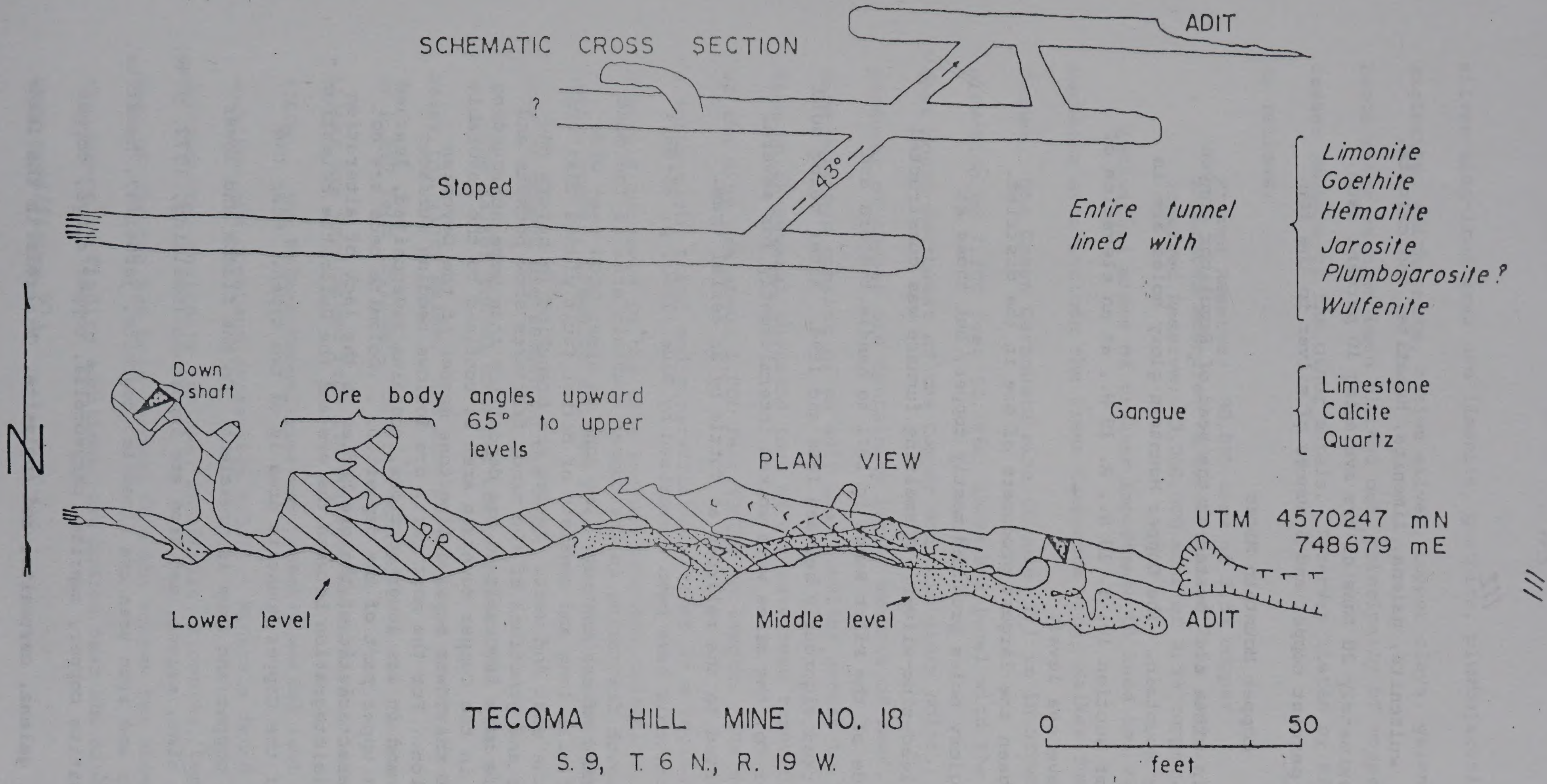
The Tecoma Hill 15, 16, and 17 mines are on the north side of Regulator Canyon and on the south side of Tecoma Hill. They are located in NENWNW 9-6N-19W at an elevation of 6,490 feet (1,978m) above sea level. Mineralization explored by this group of adits began in the early days of the camp, being very near the initial Tecoma mine discoveries. It is estimated that a few hundred tons of ore were produced. Mine workings consist of three adits and several prospect pits having a total length of 1,000 feet (305m).

Mineralization occurs in the Fish Haven and Laketown Dolomites and is associated with northeast fractures and faults. The mineralization consists of fissure fillings and as replacements of favorable strata along these structures. The mineralogy is the same as for the Tecoma mine. There are no observable reserves of lead and zinc in the mines.

Empire Mine

The Empire, or Tecoma Hill 18 mine (Doelling, 1972), is on the north side of Regulator Canyon. It is in the NWSESW 9-6N-19W at an elevation of 6,610 feet (2,015m) above sea level (figure 38). The mine was discovered in the early days of the camp and produced a few hundred tons of silver-lead ore. Mine workings consist of an adit from which a winze was sunk with two sublevels developed along a mineralized fissure.

The mine is cut in the Silurian Laketown Dolomite and mineralization is along a fissure striking N90E and dipping 65 degrees south. Mineralization consists of a fissure filling and replacement of adjacent dolomite fractured by movement along the structure. Minerals observed in the mine are anglesite,



Adapted from Deolling, 1972

Figure 38: Empire mine map

cerussite, smithsonite, wulfenite, galena, limonite, hematite, and calcite. The mine contains approximately 20 tons of ore averaging 10 percent lead, 0.5 percent zinc, 0.05 percent copper and 5 ounces of silver to the ton.

Copper Mountain Mines

The Copper Mountain mines are located at the head of Regulator Canyon near the apex of Copper Mountain. The Copper Mountain glory holes are in the southwest quarter of section 10, T. 10 N., R. 19 W., at an elevation of 7,260 feet (2,213m) above sea level.

These mines have been the largest producers of ore in the district. The workings near the glory holes produced mostly copper, but those at lower levels produced lead-zinc-silver. A smelting furnace was constructed at Buel on the west side of the Pilot Range in 1871 to handle the ore and the properties were worked vigorously between 1886 and 1894. After being sold to the Salt Lake Copper Co. the mines were worked intermittently for several years, the ore transported to the railroad at Tuttle by an aerial tram.

Geology and ore controls have been summarized by Blue (1960, p. 85-88):

> "....north-south fracturing in the Copper Mountain area is the most significant in terms of ore control. The zone is about 1000 feet wide and over one-half mile long and consists of normal fault planes that dip steeply both to the east and west. Faults are branching in nature and the intersections and junctions of the minor fractures show pockets and cavities that were more favorable to ore deposition than were surrounding areas... ...Ore in the Copper Mountain area is confined to the favorable carbonate beds of the lower massive limestone member of the Devonian Guilmette Formation. For the most part, ore follows bedding surfaces in the limestone and in its lower portions, contains redeposited, leached material from the upper part of the deposit... ...Dolomite beds are not mineralized. Characteristic of the ore bodies is the lack of alteration other than the disintegration between the ore and the Guilmette Formation."

Mineralization of the Copper Mountain area is of two types. Near the crest of the mountain copper and iron is prevalent. On the flanks and lower on the mountain lead, zinc, silver, and iron are important (Doelling, 1972, p.46). Minerals in the copper and iron area are limonite, goethite, jarosite?, hematite, azurite, malachite, native copper, cuprite, chrysocolla, copper clays, copper pitch, native silver, galena, cerussite, and anglesite. Minerals in the lead-silver-zinc-iron area are limonite, goethite, plumbojarosite, hematite, cerussite, anglesite, smithsonite, native silver, copper clays, galena and sphalerite. Large reserves have been blocked out, principally of copper ore containing lesser amounts of the other metals. Reserves listed by Blue (1960, p. 91) are as follows:

Proven Reserve: 80,035 tons of 2.5% copper
Indicated Reserve: 130,240 tons of 2.5% copper
Inferred Reserve: 3,000,000 tons of 2.5% copper.

Individual mines of greater importance to lead and zinc in the Copper Mountain area include the Green Carbonate mine, Walker Tunnel and Vesuvius Tunnel. The Green Carbonate mine (figure 39) is in SESWSW 10-6N-19W at an elevation of 7,200 feet (2,195m) above sea level with the portal about 1,000 feet south-southwest of the Copper Mountain glory holes. It was mainly a producer of copper ore containing lesser amounts of lead, silver, and zinc. Mine workings consist of an adit that provides access to two large open stopes from which several thousand tons of ore have been removed. The total workings of the mine are about 1,000 feet (305m) in length. The stopes are along a north-south trend and mineralization occurs as a replacement of the limestone. Minerals observed in the mine include azurite, malachite, chrysocolla, cuprite, native copper, limonite and hematite. Several hundred to several thousand tons of copper ore remain in the mine.

The Walker Tunnel mine has its portal on the east side of Copper Mountain below the glory holes. The mine portal is in NWNESW 10-6N-19W at an elevation of 6,960 feet (2,124m). Several hundred to a few thousand tons of lead-zinc-silver ore were mined from its workings which have a length of about 2,500 feet (762m). The Walker Tunnel mine was probably worked last in the 1940s, the workings are open and accessible (1972). Minerals found in the mine are cerussite, smithsonite, anglesite, galena, sphalerite, limonite, hematite and calcite. Most of the ore has been removed from the stopes but some low grade ore remains. The chance of finding additional ore bodies near the mine of the same type is very good (figure 40).

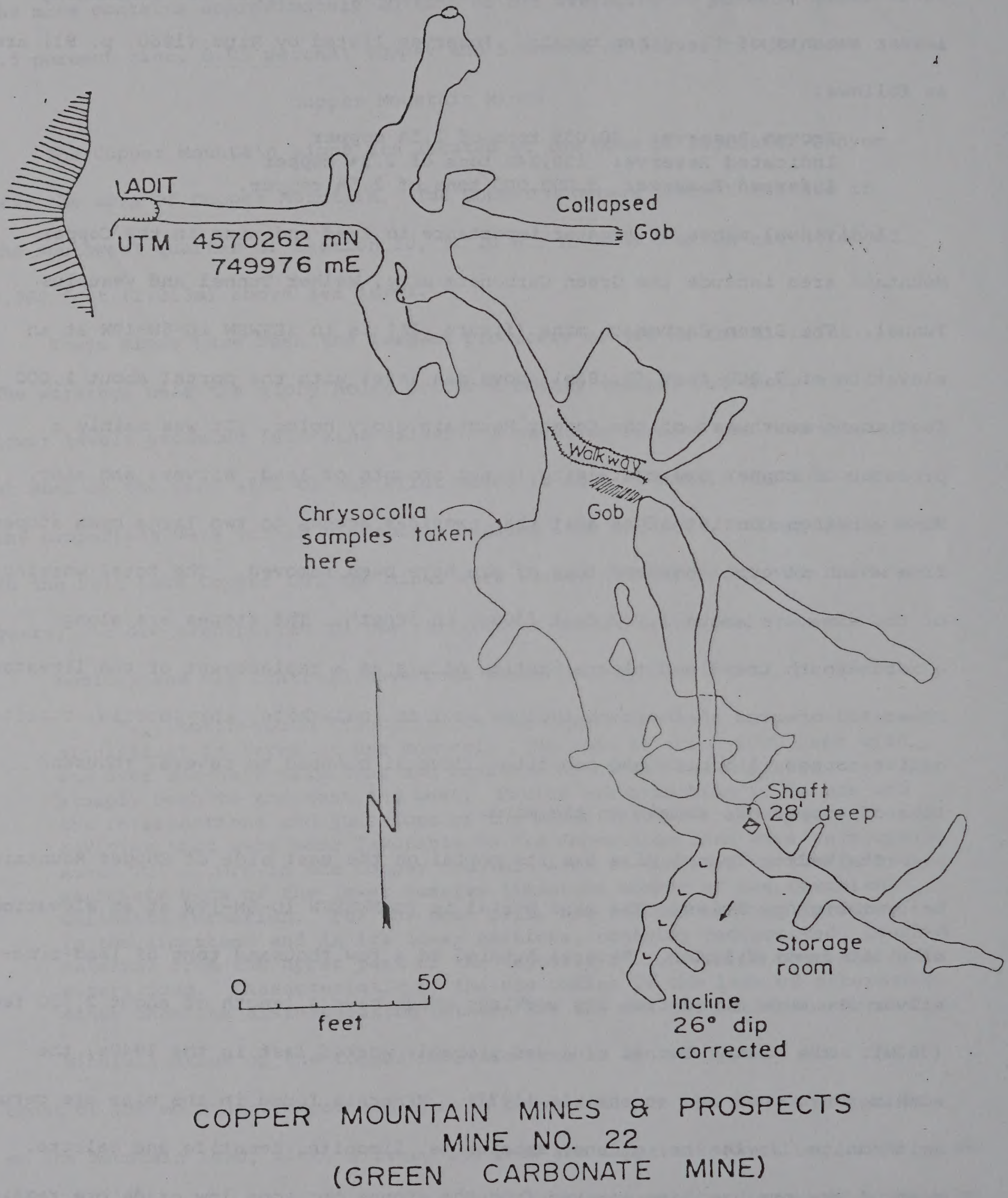
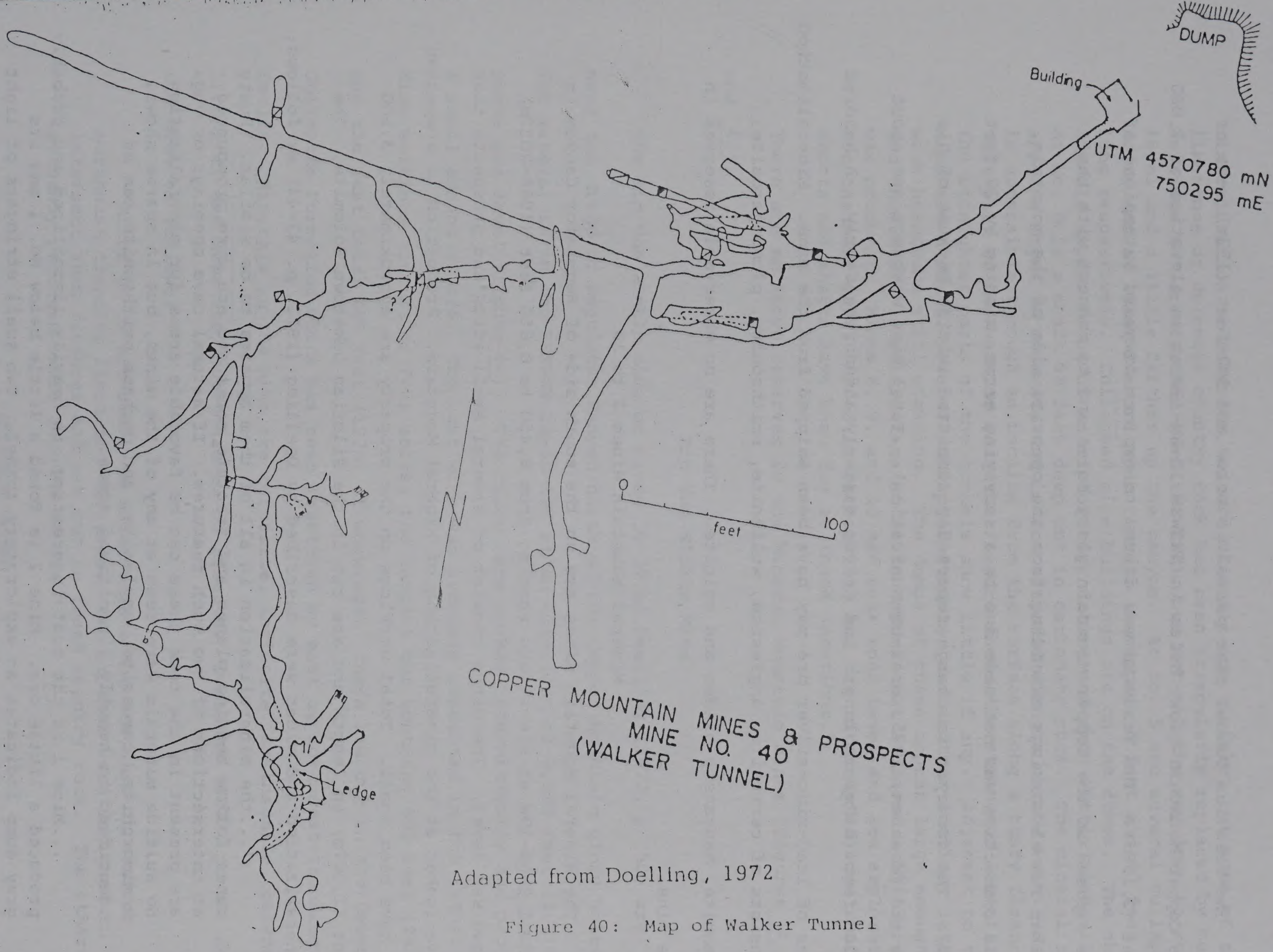


Figure 39: Green Carbonate mine map
Adapted from Doelling, 1972



Adapted from Doelling, 1972

Figure 40: Map of Walker Tunnel

AE

The Vesuvius Tunnel mine portal is below and 500 feet (152m) west of the Copper Mountain glory holes in NWSWSW 10-6N-19W at an elevation of 7,080 feet (2,158m). The Vesuvius was driven to explore downward extensions of ore exposed in the Copper Mountain glory holes and to connect with the Walker Tunnel workings extending from the opposite side of the mountain. This connection was not made due to a surveying error, missing by 20 feet (6m). The surveyor in charge reportedly committed suicide because of his mistake (Wheaton, 1975, oral communication). Total mine workings are about 2,000 feet (610m) in length and driven easterly and northeasterly. A hundred tons of lead-zinc-silver ore may have been shipped from the mine. Mineralization consists of cerrusite, anglesite, wulfenite, smithsonite, plumbojarosite, limonite, manganese oxides and calcite. There are no observable reserves in the mine.

Mineral Mountain Mines 1 to 10

The Mineral Mountain mines are on the south side of Regulator Canyon in SWSWSE 9-6N-19W at elevations ranging from 6,450 to 6,650 feet (1966-2027m) above sea level. The mines consist of several small adits and prospects that have looked at the mineralization of Mineral Mountain. Production is suspected to have been small. Total workings on the property are approximately 3,500 feet (1,067m) in length and are cut in the Silurian Laketown Dolomite. The mineralization and mines were described by Doelling (1972, p. 43-44) as follows:

> "...the mineralization in all of them appears to be similar. Rusty zones follow bedding planes and fracture zones and are more pronounced at intersections of two such features. If natural cave openings or vugs are present in the rock these can be favorable areas for mineralization. No sulfide minerals were seen at any of the mines, but in sparse shows, hemimorphite, cerussite, anglesite, and perhaps smithsonite can be identified in heavily limonitized zones...
>
> ...Mine 1 is the most interesting, is heavily limonitized and probably produced a little ore. Mine 2 is found a little below No. 1 and its gray dump indicates an exploratory tunnel. Two small stringers of light limonite were intersected but no ore was discovered. No. 3 is not shown, but is a 6-foot deep pit, with an adjoining 6-foot tunnel. These are in a rusty zone about 30 feet northwest of No. 4. The No. 4 workings consist of a lower tunnel and an upper cut and start of a tunnel. The limonite

> mineralization is moderate, no ore minerals are visible, but some of the limestone or dolomite country rock has been irregularly replaced by barite. Workings 5-7 are farther down the hill, but not all the way down to road level and a little farther up the canyon. At No. 5 are several collapsed adits and at least 2 short open tunnels (unmapped) 6 feet and 40 feet long respectively. Collapsed mine buildings are on the dumps. The short tunnels appear to be of an exploratory nature and show little mineralization. At No. 6 is a shaft 68 feet deep cut in carbonate rock. The mineralization appears light to moderate and is concentrated along a narrow vein. No. 7 is accessible through an incline from the surface along a rusty fissure. That part of the working near the fissure shows the strongest limonitization, the straighter parts of the tunnels show little if any. Adjacent to this mine are a shaft, several collapsed tunnels, and another incline, latter with headframe still standing. The dumps of these appear large enough and show heavy limonitization so as to assume that at least a little ore was produced. Mines 8, 9, and 10 are near road level and are exploratory for the most part. No. 8 is rather long and has intercepted some rusty shoots and shafts have been dug at these locations."

There are no known reserves in the Mineral Mountain mines (figures 41, 42, and 43).

Rip Van Winkle Mine

The Rip Van Winkle mine or Mines 36-39 of Doelling (1972, p. 50) are near the head of Regulator Canyon north of the Copper Mountain glory holes. The mine(s) is in the SESWNW 10-6N-19W at an elevation of 7,280 feet (2,219m) above sea level (figure 44). The mines were worked intermittently and produced a small amount of ore. The last work was probably conducted in the 1940s. Mine workings consist of four adits, the largest one contains 800 feet (244m) and the rest total 400 feet (122m) of workings. These are cut in the Devonian Guilmette Formation which has been fractured by east or northeast-trending faults. Minerals in the mine are cerussite, anglesite, smithsonite, galena?, limonite, and hematite, but there is no reserve. Doelling (1972, p. 50) describes the mine as follows:

> "Mines 36-39 are small to intermediate and are also on east or northeast trending limonitic fissures. Two of them were designed to intersect such fissures and are cut in fresh country rock. The others probably produced small amounts of ore."

Cunepah Mine

The Cunepah mine workings are one mile (1.6km) northwest of Patterson

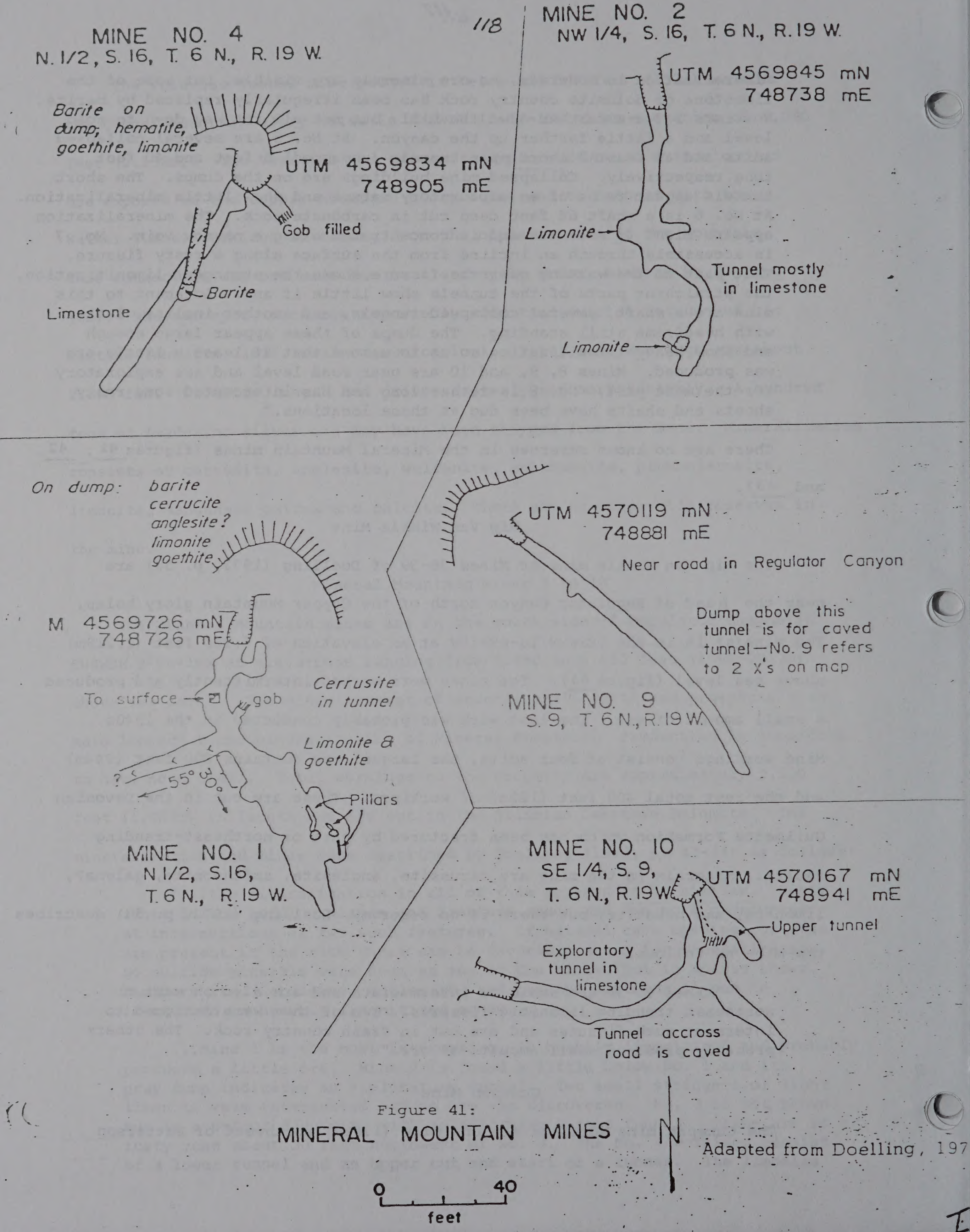


Figure 41:
MINERAL MOUNTAIN MINES

Adapted from Doelling, 197

I

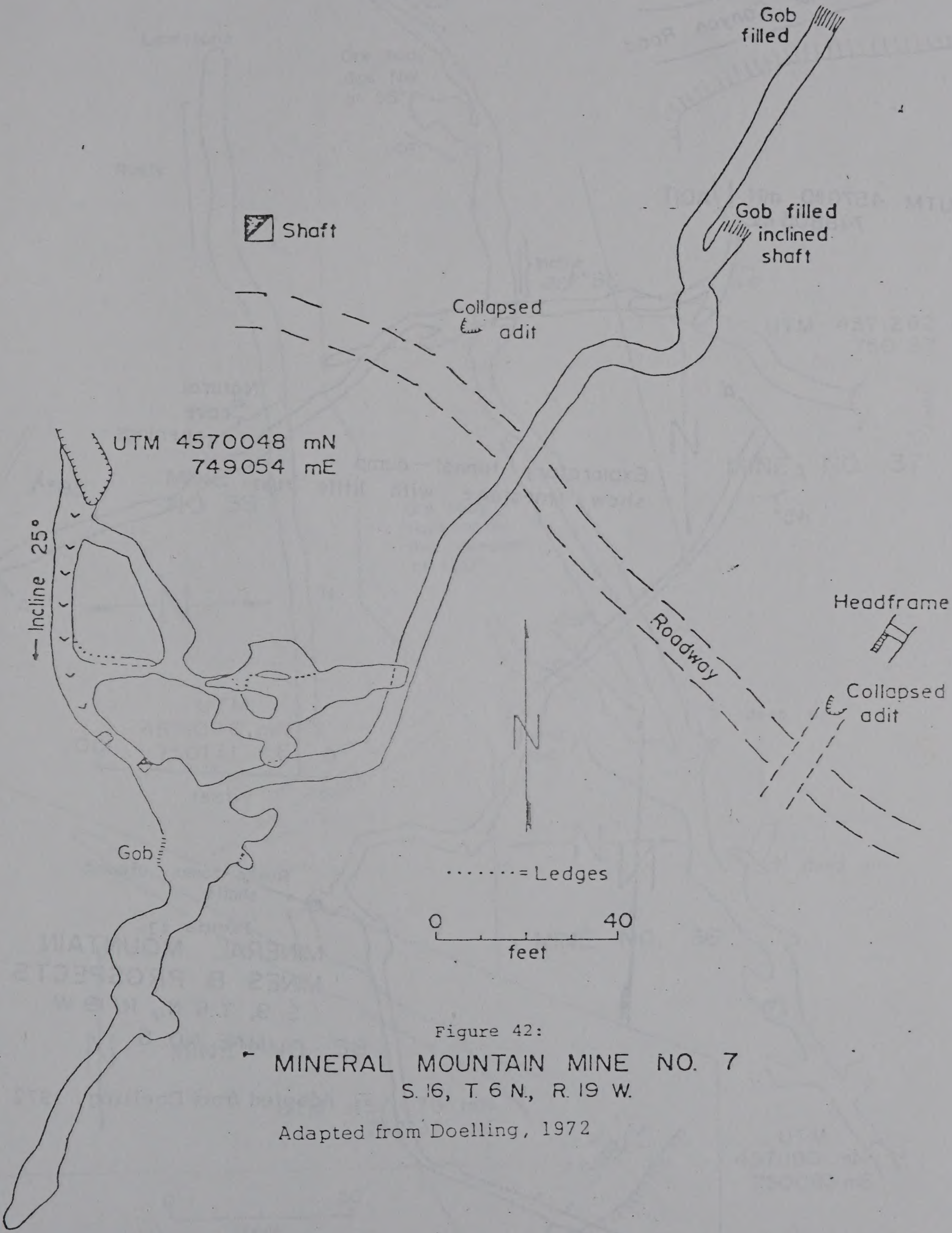


Figure 42:

MINERAL MOUNTAIN MINE NO. 7

S. 16, T. 6 N., R. 19 W.

Adapted from Doelling, 1972

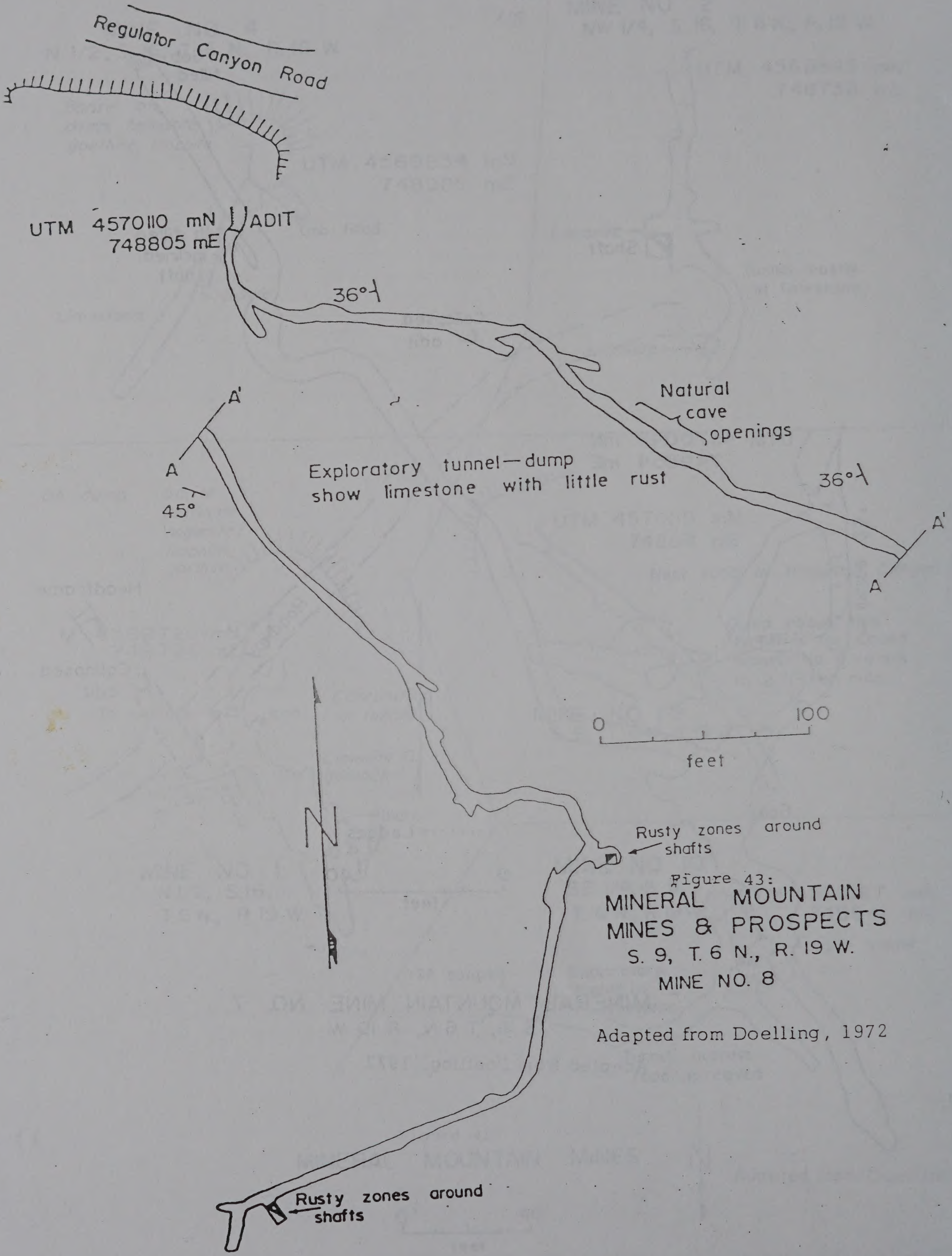

Regulator Canyon Road
UTM 4570110 mN
748805 mE
ADIT
36°
Natural cave openings
A'
A
45°
Exploratory tunnel—dump show limestone with little rust
36°
A'
A
0
100
feet
N
Rusty zones around shafts
Rusty zones around shafts

Figure 43:
MINERAL MOUNTAIN MINES & PROSPECTS
S. 9, T. 6 N., R. 19 W.
MINE NO. 8

Adapted from Doelling, 1972

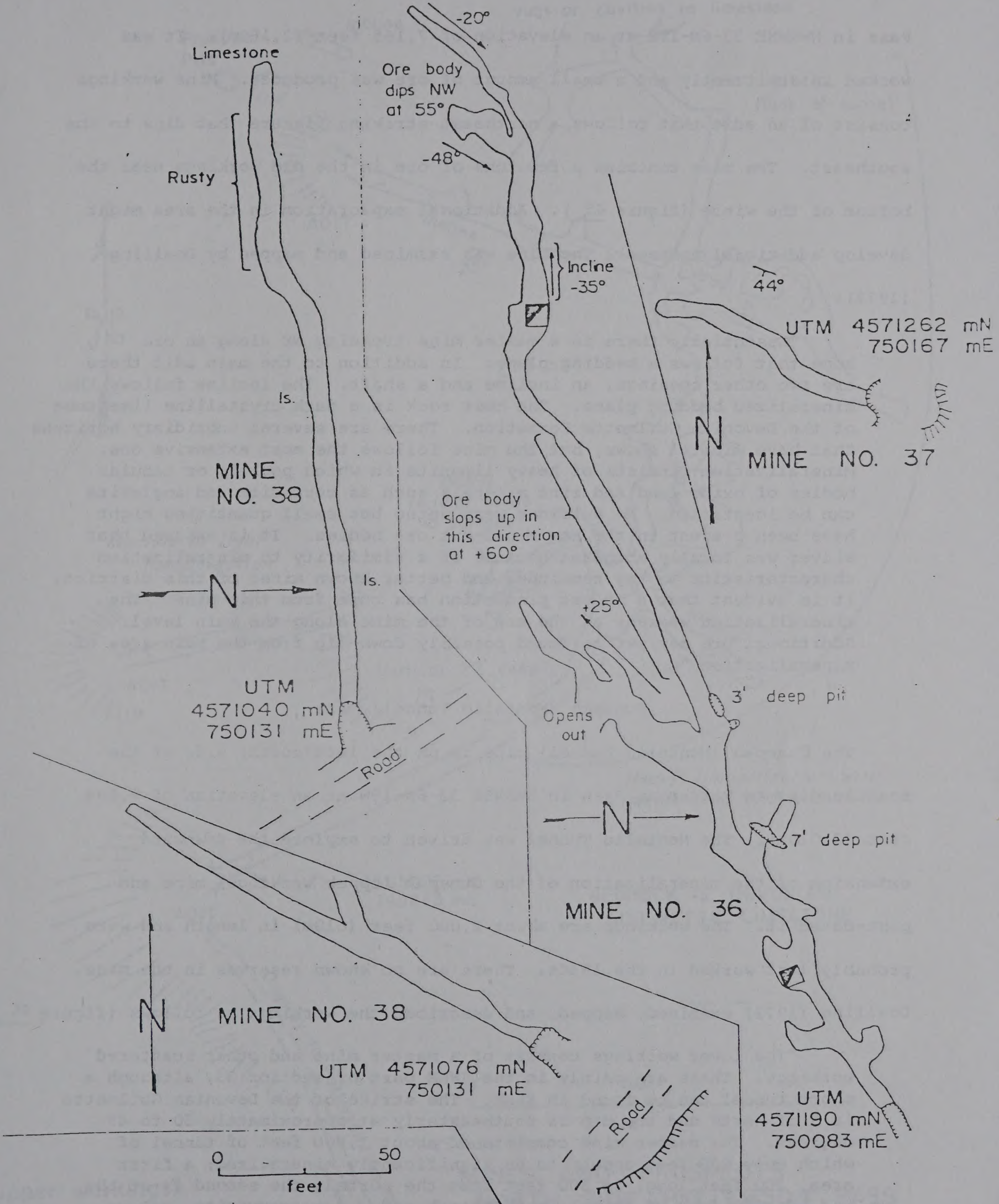


Figure 44: COPPER MOUNTAIN MINES & PROSPECTS
Adapted from Doelling, 1972

AD

Pass in NWNWNE 33-6N-19W at an elevation of 7,165 feet (2,183m). It was worked intermittently and a small amount of ore was produced. Mine workings consist of an adit that follows a northeast-striking fissure that dips to the southeast. The mine contains a few tons of ore in the old workings near the bottom of the winze (figure 45). Additional exploration in the area might develop additional tonnage. The mine was examined and mapped by Doelling (1972):

> "Essentially there is a master mine trending NE along an ore zone that follows a bedding plane. In addition to the main adit there are two other openings, an incline and a shaft. The incline follows the mineralized bedding plane. The host rock is a dark crystalline limestone of the Devonian Guilmette Formation. There are several subsidiary horizons that have mineral shows, but the mine follows the most extensive one. Mineralization consists of heavy limonite in which pockets or tabular bodies of oxide lead and zinc minerals such as cerussite and anglesite can be identified. No sulfides were noted but small quantities might have been present in the now mined-out ore bodies. It is assumed that silver was locally abundant because of a similarity to mineralization characteristics to the remainder and better known mines of this district. It is evident that a modest production has come from this mine. The mineralization weakens at the end of the mine along the main level. Additional ore may yet be found possibly down-dip from the main area of mineralization."

Cunepah (Montello Tunnel) Mine

The Cunepah (Montello tunnel) mine is on the left(north) side of the road leading to Patterson Pass in SWSWSE 33-6N-19W at an elevation of 6,594 feet (2,010m). The Montello Tunnel was driven to explore the downward extension of the mineralization of the Cunepah (upper workings) mine and post-dated it. The workings are about 2,000 feet (610m) in length and were probably last worked in the 1940s. There are no known reserves in the mine. Doelling (1972) examined, mapped, and described the workings as follows (figure 46):

> "The lower workings consist of a master mine and other scattered workings. These are mainly in the SWNE part of section 33, although a short tunnel can be found in SENE. The strike of the Devonian Guilmette is E of north and the dip is southeasterly at approximately 30 to 45 degrees. The master mine consists of about 1,800 feet of tunnel of which only 600 feet appear to be significantly mineralized; a first area, 200 feet long, is 500 feet from the portal, the second is at the end of 1200 feet of tunnel at the north end. Some cerussite, galena, and perhaps anglesite were noted in these mineralized areas and on the dump. A small amount of ore was probably produced from this mine."

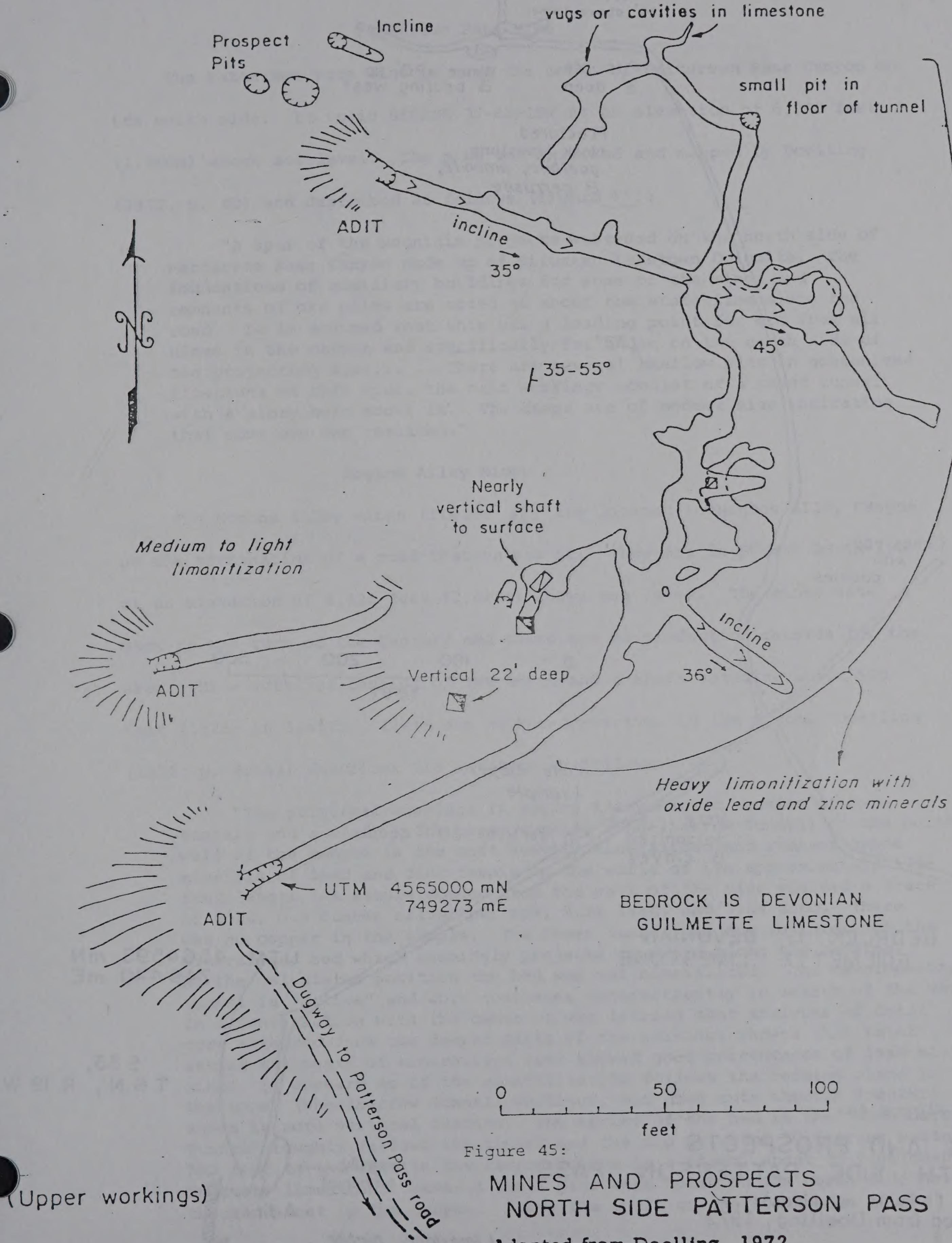

Prospect Pits
Incline
vugs or cavities in limestone
small pit in floor of tunnel
ADIT
incline
35°
45°
35-55°
Nearly vertical shaft to surface
Medium to light limonitization
ADIT
Incline
36°
Vertical 22' deep
Heavy limonitization with oxide lead and zinc minerals
ADIT
UTM 4565000 mN 749273 mE
BEDROCK IS DEVONIAN GUILMETTE LIMESTONE
Dugway to Patterson Pass road
0
50
100
feet
(Upper workings)

Figure 45:

MINES AND PROSPECTS
NORTH SIDE PATTERSON PASS

Adapted from Doelling, 1972

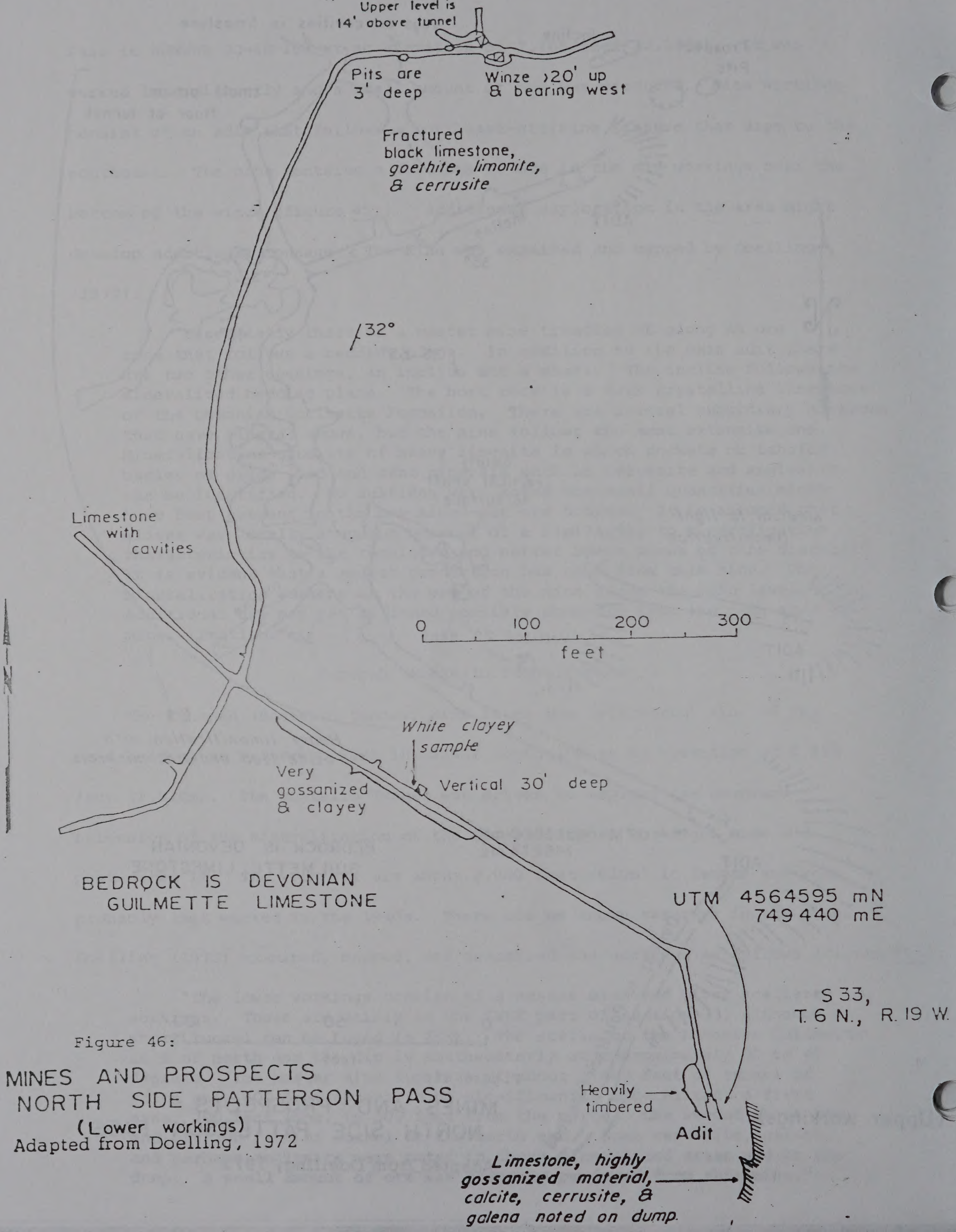

Upper level is 14' above tunnel
Pits are 3' deep
Winze >20' up & bearing west
Fractured black limestone, *goethite, limonite, & cerrusite*
32°
Limestone with cavities
0 100 200 300
feet
N
White clayey sample
Very gossanized & clayey
Vertical 30' deep
BEDROCK IS DEVONIAN GUILMETTE LIMESTONE
UTM 4564595 mN 749 440 mE
S 33, T. 6 N., R. 19 W.
Heavily timbered
Adit
Limestone, highly gossanized material, calcite, cerrusite, & galena noted on dump.

Figure 46:

MINES AND PROSPECTS
NORTH SIDE PATTERSON PASS
(Lower workings)
Adapted from Doelling, 1972

Patterson Pass Mine

The Patterson Pass mine is near the mouth of Patterson Pass Canyon on its north side. It is in SESENE 32-6N-19W at an elevation of 6,200 feet (1,890m) above sea level. The mine was examined and mapped by Doelling (1972, p. 40) and described as follows (figure 47):

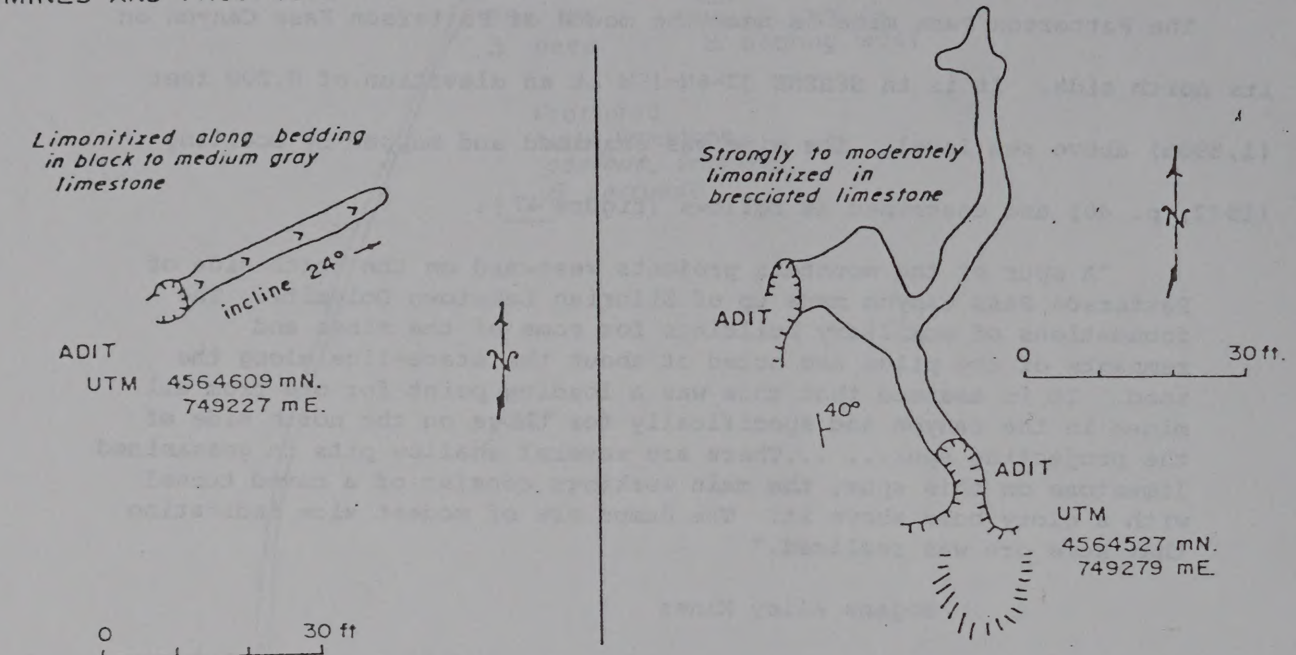
> "A spur of the mountain projects westward on the north side of Patterson Pass Canyon made up of Silurian Laketown Dolomite. The foundations of auxiliary buildings for some of the mines and remnants of ore piles are noted at about the state-line along the road. It is assumed that this was a loading point for ore from all mines in the canyon and specifically for those on the north side of the projecting spur... ...There are several shallow pits in gossanized limestone on this spur, the main workings consist of a caved tunnel with a glory hole above it. The dumps are of modest size indicating that some ore was realized."

Hogans Alley Mines

The Hogans Alley mines (figure 48) are located in Hogans Alley Canyon at the termination of a road that enters it. They are in SWNWNE 28-6N-19W at an elevation of 6,621 feet (2,018m) above sea level. The mines date back to the turn of the Century and there are no production records for the area. Mine workings consist of two adits and a shaft totaling about 500 feet (152m) in length. There are no known reserves in the mines. Doelling (1972, p. 40-41) describes the workings as follows:

> "The principal workings in Hogans Alley Canyon consist of two tunnels and a shaft. The upper working (Wheelbarrow Tunnel) on the north wall of the canyon is the most heavily mineralized and remnant oxide minerals of lead and zinc remain on the walls of its approximately 175-foot length. A sample gouged from the wall of the mine yielded a trace of gold, 0.9 ounces silver per ton, 9.2% lead, and 7.5% zinc. There was no copper in the sample. The lower tunnel was dug to intersect the mineralized bed which seemingly projects downward along the bedding. At the calculated position the bed was not mineralized. The developmental tunnel is "active" and work continues intermittently in search of the vein. In a conversation with the owner it was learned that analyses of drill core extended from the deeper parts of the workings showed that intersected stringers of mineralized rock showed good percentages of lead-silver-zinc. It appears as if the mineralization follows the bedding plane in the upper (Wheelbarrow Tunnel) workings, but then cuts through fracture zones in more vertical fashion. The strike of the bed in the "Wheelbarrow Tunnel" roughly follows the tunnel and the dip is about 50 degrees easterly. 500 feet to the east in the canyon bottom is a shaft, about 30 feet deep in rusty limestone. Several small pits were noted on the north side several thousand feet up the canyon. Above the shaft on the south side of the

MINES AND PROSPECTS NORTH SIDE PATTERSON PASS (Lower workings continued)


Limonitized along bedding in black to medium gray limestone
incline
24°
ADIT
UTM 4564609 mN.
749227 mE.
0
30 ft
Strongly to moderately limonitized in brecciated limestone
ADIT
40°
ADIT
UTM
4564527 mN.
749279 mE.
0
30 ft.

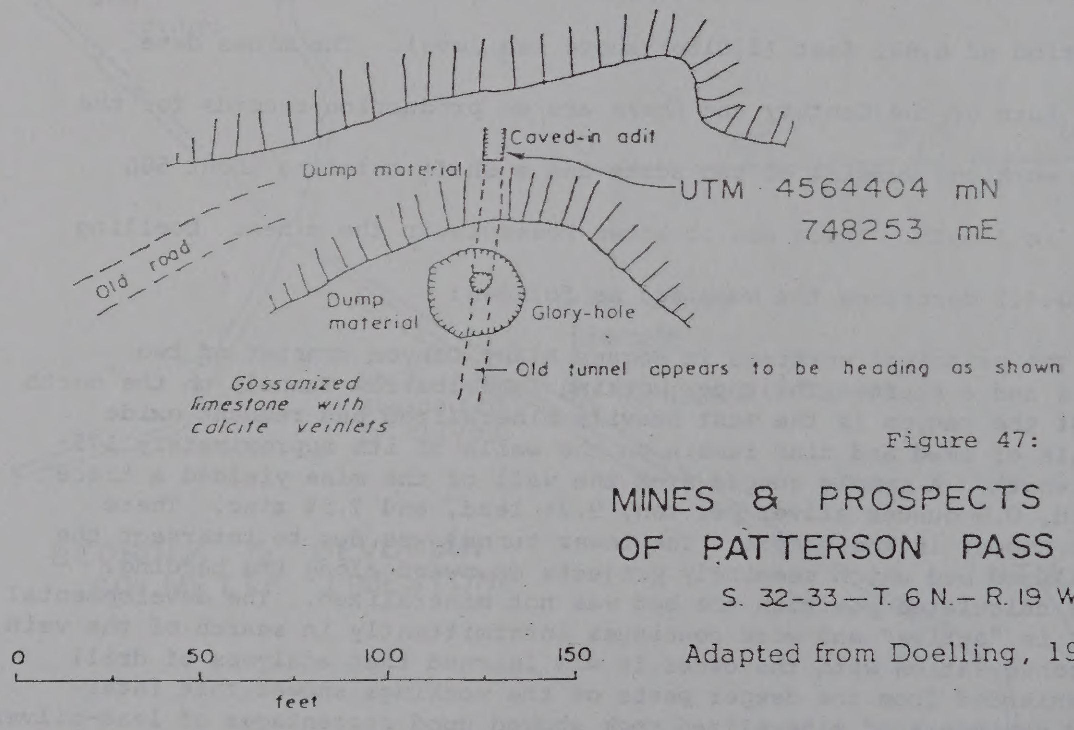
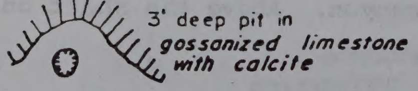


Figure 47:

MINES & PROSPECTS NEAR MOUTH OF PATTERSON PASS CANYON

S. 32-33—T. 6 N.—R. 19 W.

Adapted from Doelling, 1972



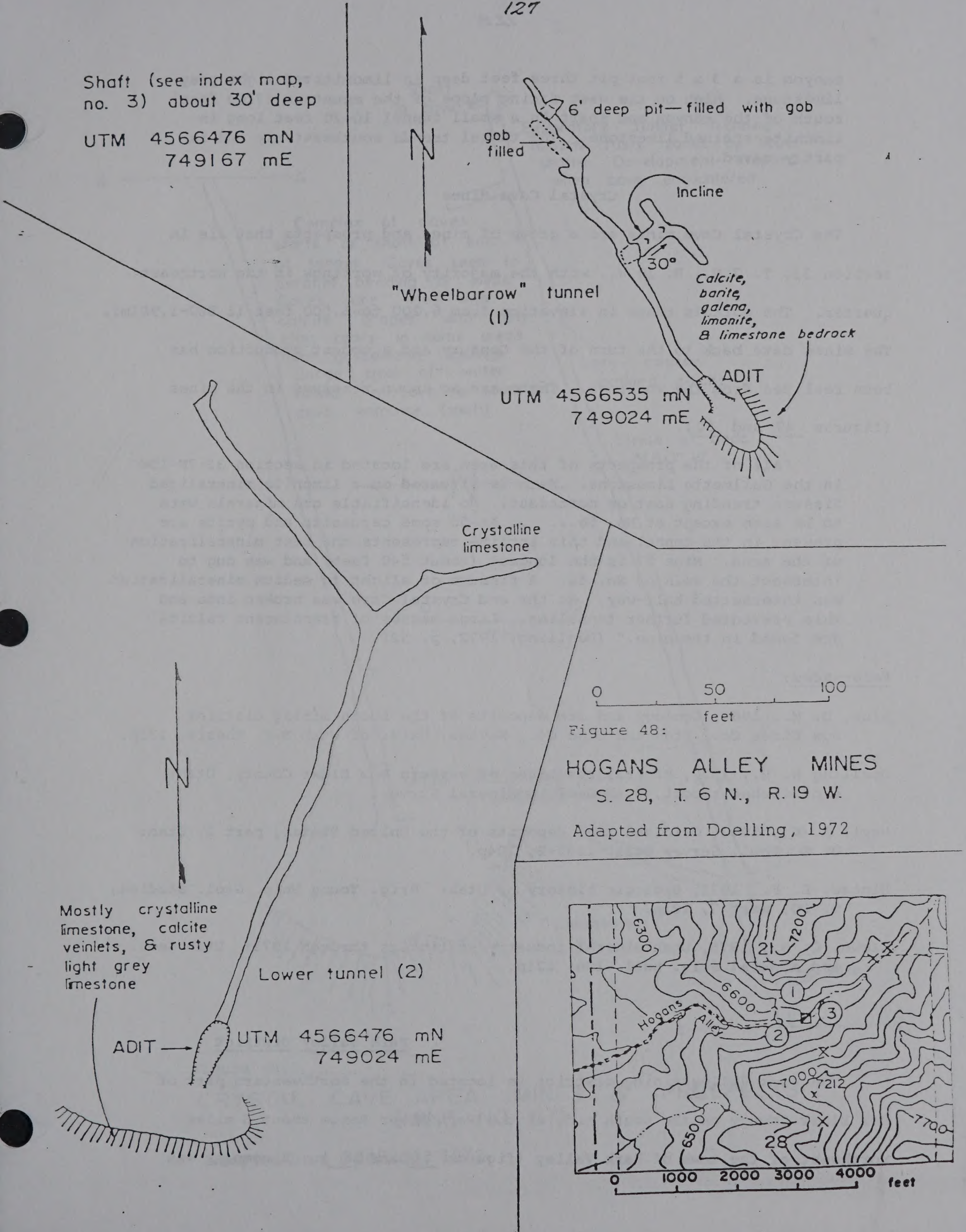


Figure 48:

HOGANS ALLEY MINES
S. 28, T. 6 N., R. 19 W.

Adapted from Doelling, 1972

canyon is a 3 x 5 foot pit three feet deep in limonitized light gray limestone. High on the west facing slope of the mountain (7100 feet) south of the canyon and shaft is a small tunnel 10-20 feet long in limonite-stained limestone. The tunnel trends southeasterly and is partly caved.

Crystal Cave Mines

The Crystal Cave mines are a group of mines and prospects that lie in section 33, T. 7 N., R. 19 W., with the majority of workings in the northeast quarter. The portals range in elevation from 6,200 to 6,500 feet (1,880-1,981m). The mines date back to the turn of the Century and a modest production has been realized from the workings. There are no known reserves in the mines (figures 49 and 50).

> "All of the prospects of this area are located in section 33-7N-19W in the Guilmette Limestone. Each is situated on a limonite mineralized fissure trending east or northeast. No identifiable ore minerals were to be seen except at No. 56... ...At 56 some cerussite and pyrite are present in the tunnel and this incline represents the best mineralization of the area. Mine 57 is the longest (about 540 feet) and was dug to intersect the vein of No. 56. A fissure of slight to medium mineralization was intersected half-way. At the end Crystal Cave was broken into and this prevented further tunneling. Large masses of translucent calcite are found in the mine." (Doelling, 1972, p. 52)

References:

Blue, D. M., 1960, Geology and ore deposits of the Lucin mining district, Box Elder Co., Utah and Elko Co., Nevada: Univ. of Utah M.S. thesis, 121p.

Doelling H. H., 1972, Mineral resources of western Box Elder County, Utah: unpublished report, Utah Geol. & Mineral Survey.

Heyl, A. V., 1963, Oxidized zinc deposits of the United States, part 2, Utah: U. S. Geol. Survey Bull. 1135-B, 104p.

Hintze, L. F., 1973, Geologic history of Utah: Brig. Young Univ. Geol. Studies, v. 20, part 3, 181p.

Stowe, C. H., 1975, Utah mineral industry statistics through 1973: Utah Geol. and Mineral Surv. Bull. 106, 121p.

Park Valley District

The Park Valley mining district is located in the northwestern part of Box Elder County on the south side of the Raft River Range about 8 miles northwest of the town of Park Valley (figures 51 and 52). A company was

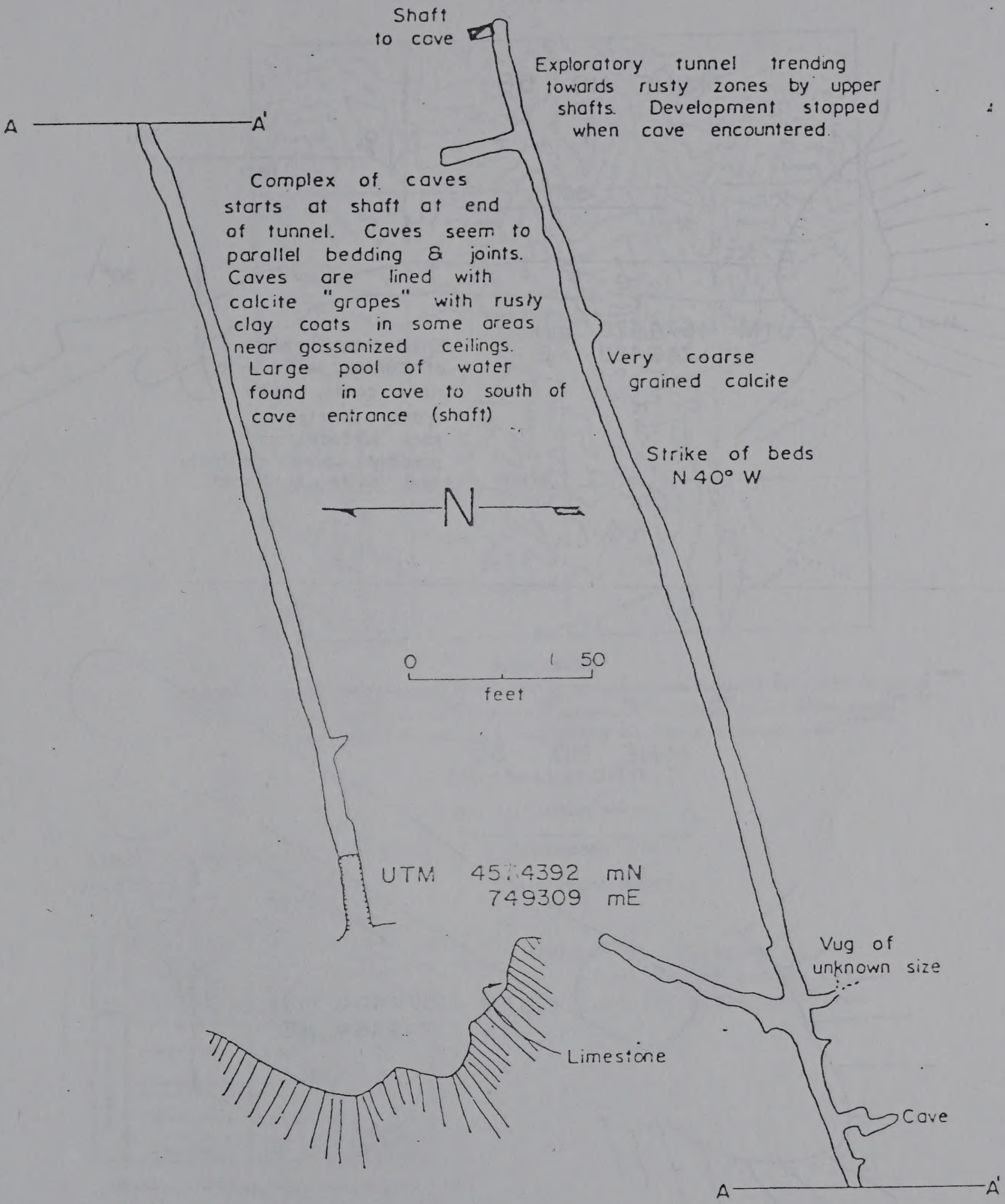

Shaft to cave
Exploratory tunnel trending towards rusty zones by upper shafts. Development stopped when cave encountered.
A
A'
Complex of caves starts at shaft at end of tunnel. Caves seem to parallel bedding & joints. Caves are lined with calcite "grapes" with rusty clay coats in some areas near gossanized ceilings. Large pool of water found in cave to south of cave entrance (shaft)
Very coarse grained calcite
Strike of beds N 40° W
N
0
50
feet
UTM 45[illegible]4392 mN
749309 mE
Vug of unknown size
Limestone
Cave
A
A'

Figure 49:

CRYSTAL CAVE AREA MINES & PROSPECTS
(MINE NO. 57)

Adapted from Doelling, 1972

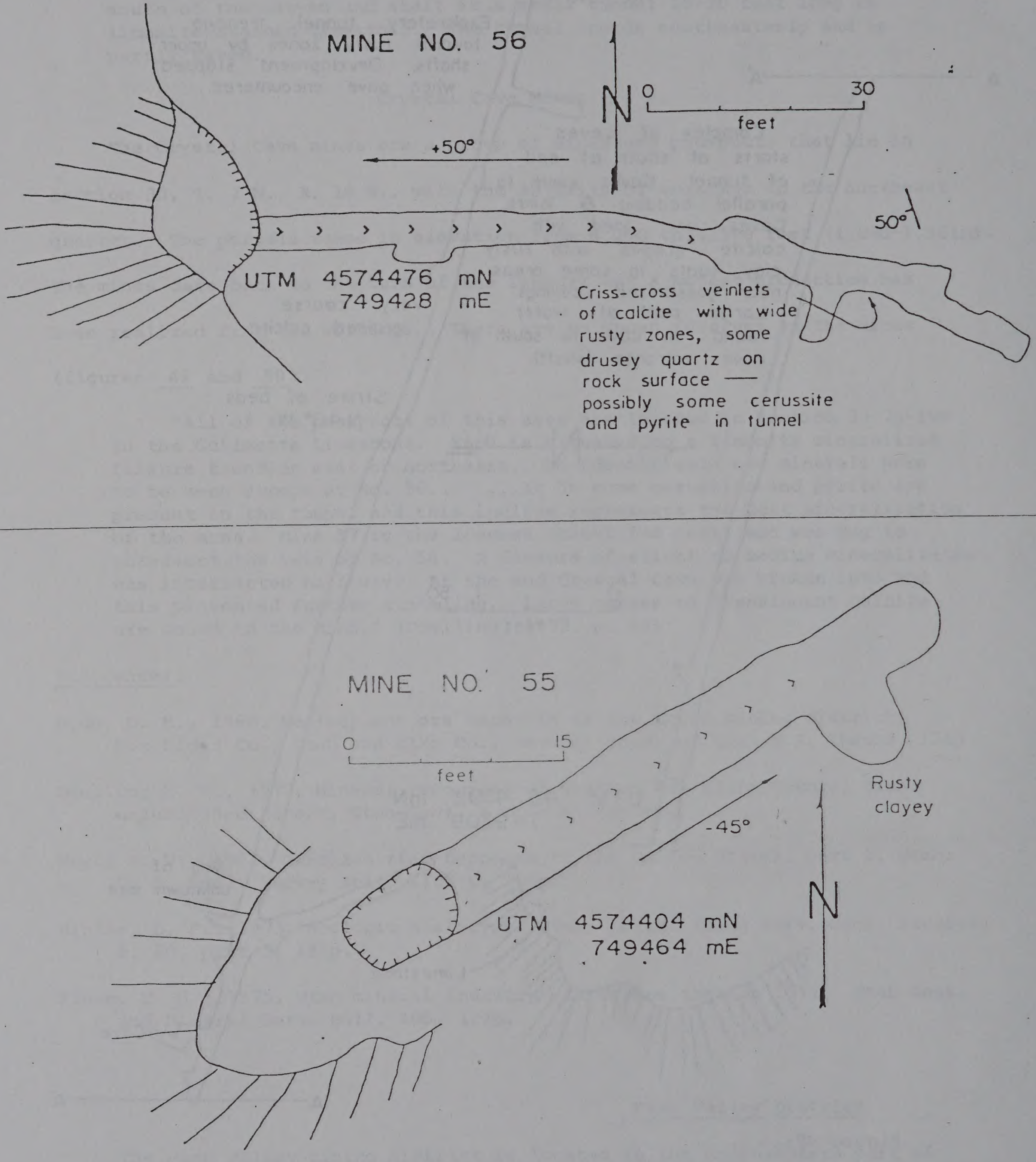
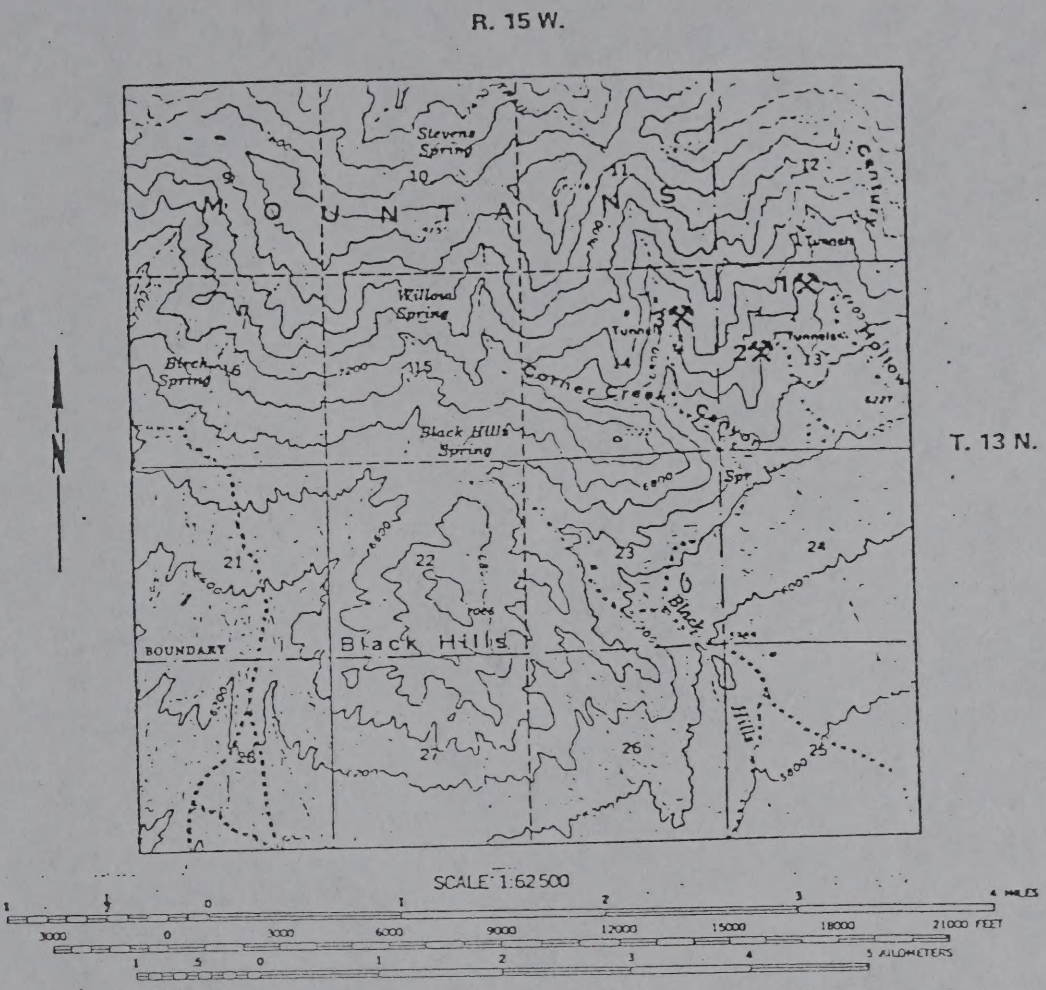

MINE NO. 56
N
0
30
feet
+50°
50°
UTM 4574476 mN
749428 mE
Criss-cross veinlets of calcite with wide rusty zones, some drusey quartz on rock surface — possibly some cerussite and pyrite in tunnel
MINE NO. 55
0
15
feet
Rusty clayey
-45°
N
UTM 4574404 mN
749464 mE

Figure 50:

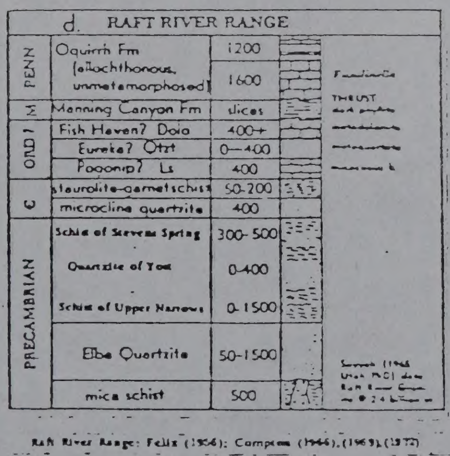
CRYSTAL CAVE AREA MINES & PROSPECTS

Adapted from Doelling, 1972



PARK VALLEY DISTRICT

1. Century mine
2. Susannah mine
3. Unknown mine



d. RAFT RIVER RANGE		
PENN	Oquirrh Fm (allochthonous, unmetamorphosed)	1200
		1600
M	Manning Canyon Fm	slices
ORD ?	Fish Haven? Dolo	400+
	Eureka? Qtzt	0—400
	Pogonip? Ls	400
Є	staurolite-garnet schist	50-200
	microcline quartzite	400
PRECAMBRIAN	Schist of Stevens Spring	300-500
	Quartzite of Yost	0-400
	Schist of Upper Narrows	0-1500
	Elba Quartzite	50-1500
	mica schist	500

Raft River Range: Felix (1956); Compton (1966), (1969), (1972)

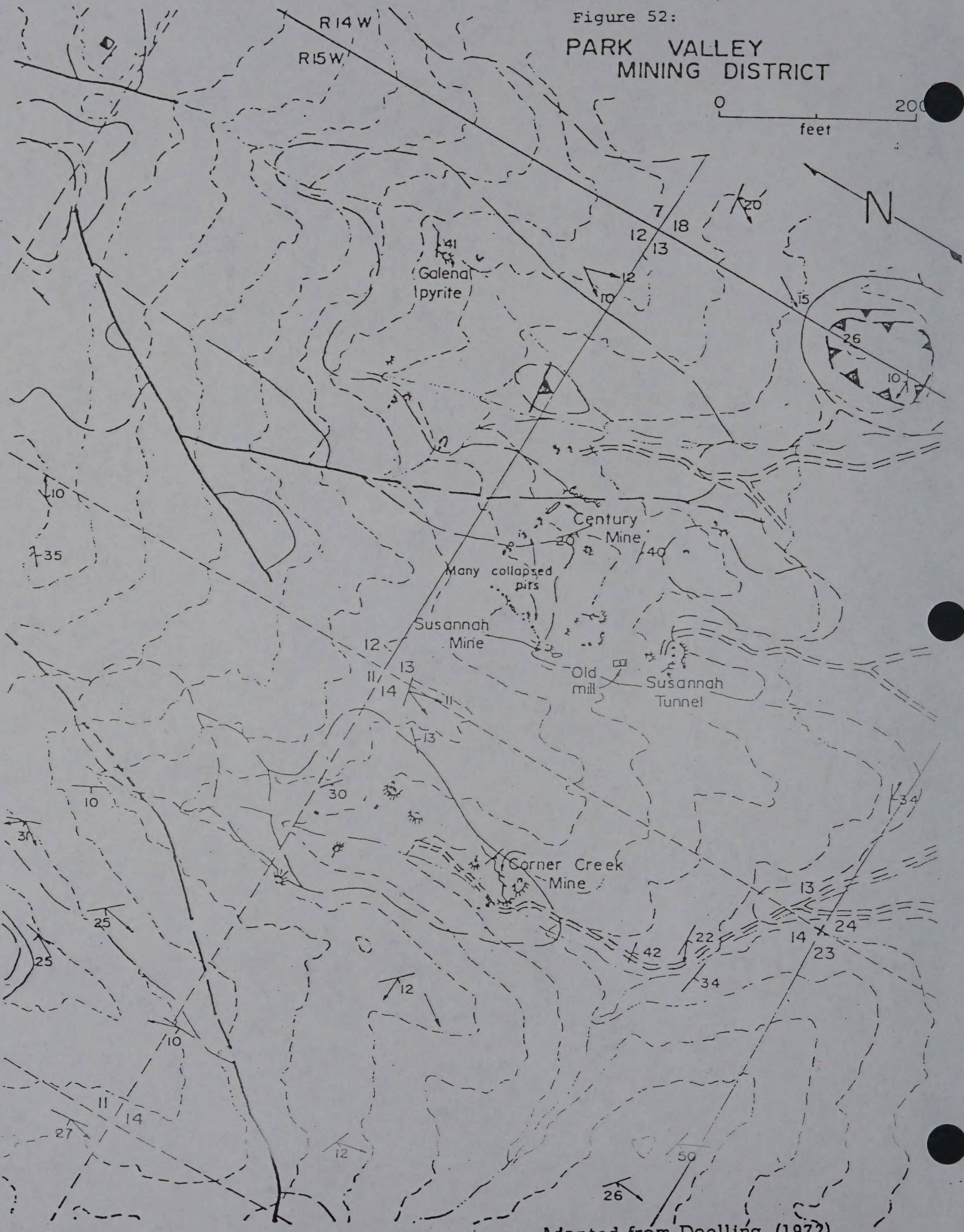
From Hintze, 1973, p. 118

Figure 51: Topographic map of Park Valley mining district and its geologic column

Adapted From: USGS Yost 15' Quadrangle

Figure 52:

PARK VALLEY MINING DISTRICT



Adapted from Doelling, (1972)

formed to operate the Century mining property in 1896 and this date marks the beginning of activity for the district (Heikes, 1920, p. 497). The district has mainly been a producer of gold, but small quantities of lead, silver, copper and zinc have been produced. The last production was recorded in 1946. Recorded production (Salt Lake Mining Review and U. S. Bureau of Mines Minerals Yearbooks) coupled with a few estimates shows that 13,830 pounds of lead were produced having a value of $654. This was produced with 16,409 fine ounces of gold, 1,033 fine ounces of silver, and 950 pounds of copper.

The southwestern Raft River Range is made up of Precambrian rock, including quartzite, schist, gneiss, and coarse-grained porphyritic granite. The Precambrian rocks can be subdivided into two groups: an underlying complex of quartzite, schist, gneiss, and granite (adamellite) and an overlying bedded quartzite (Elba Quartzite).

> "The upper quartzite dips southerly, gently to moderately. The lower complex is intruded by quartz veins which terminate against the upper quartzite. The quartz veins are mineralized with native gold, galena, sphalerite, pyrite, and chalcopyrite. Secondary minerals, such as limonite and hematite, are plentiful, and malachite and azurite are also occasionally seen... ... The richer segments of the quartz veins has been in their upper parts. The ore varied greatly in tenor, some very rich and some almost barren. The veins strike easterly to northeasterly and dip steeply southward." (Doelling, 1972, p. 74)

The future of the district with respect to lead and zinc production depends on the finding of other metals, such as gold, to make it profitable. There are no significant reserves in the district. The principal mines have been the Century, Susannah, and Corner Creek mines.

Century Mine

The Century mine, the largest in the district, is located on the west side of Century Hollow, the portal is in the NENENW 13-13N-15W at an elevation of 6,710 feet (2,236m). The mine is cut in quartz veins intruded into the lower Precambrian complex of quartzite, schist, gneiss and granite. These veins are mineralized with native gold, galena, sphalerite, pyrite, arsenopyrite, chalcopyrite, malachite, azurite, limonite, and hematite. The upper parts of the

veins were richer, although the tenor varies greatly, some parts being almost barren.

Mine workings consist of two adits and numerous small prospects. The lower adit has the largest dump suggesting several hundred feet of workings. The remains of a mill are near the portal and a large amount of tailings are found below it. The portals were caved when visited (1976) and water was flowing through the caved material. The principal mine workings follow a quartz vein that strikes northeast and is almost vertical. The nature and tenor of the mineralization below the mined workings are unknown. Development would require the sinking of a shaft and pumping equipment to handle the water that would be encountered.

Susannah Mine

The Susannah mine is in the next canyon west of Century Hollow and the portal is in SESWNW 13-13N-15W at an elevation of 6,620 feet (2,018m). It is the second largest mine of the district and the earliest workings are on the westward extension of the Century vein. Mining the downward extensions of the vein(s) may yield additional ore. The geology is the same as for the Century mine, the ore deposits as described by Heikes (1920) is as follows:

> "The ore deposits occur in a series of veins that strike about N. 20° E. and dip 40-50° SE, or even more steeply... ...the Century vein, which is the most important yet developed, can be traced along the strike for several thousand feet... ...The mineral fissures cut the granite and what appear to be fragments of schist inclosed in the granite... ...The vein pinches and swells along both the strike and dip from a few inches to several feet in thickness. The vein contains several distinct kinds of filling. At many points along the hanging wall the filling consists of a pegmatitic intergrowth of quartz and orthoclase, commonly designated 'hanging wall quartz'. At other points it consists of coarse white quartz and at still other points of finer-grained quartz with sulphides and sulpharsenides or their oxidation products. The portions of the vein containing orthoclase and coarse white quartz carry little if any metal. The ore shoots are confined to the finer quartz.
>
> The unoxidized ore contains galena, sphalerite, pyrite, chalcopyrite, and arsenopyrite, and the oxidized ore probably contains their common oxidation products. Rich oxidized ore carries visible free gold. Lead is commonly regarded as an indication of relatively rich ore, and at some points at least copper is considered to be less favorable...

...Gold is the most valuable constituent of the ore, but silver and some lead have also been obtained."

Corner Canyon Mine

The Corner Canyon mine might be the Little May mine and is in the Right Fork of Corner Canyon in the SWNENE 14-13W-15W at an elevation of 6,680 feet (2,063m). A small amount of ore was probably produced. Mine workings consist of two adits and a raise along the vein between the two levels. The upper adit has approximately 800 feet (244m) of workings and the lower adit has 600 feet (183m) of workings. Raises, winzes, and stopes amount to 200 feet (61m). Total workings in the mine are 1,600 feet (488m).

The mine is cut in granite and/or augengneiss and mineralization is in a quartz vein containing galena, malachite, pyrite, limonite, hematite, arsenopyrite, and goethite. The vein was sampled in four places within the mine and assay results range from 0.04 ounces to 1.11 ounces gold, 0.65 ounces to 4.06 ounces silver, 0.023 to 0.11 percent copper, 1.09 to 8.4 percent lead, and 0.068 to 0.072 percent zinc. A ton or two of ore remain in the mine, but additional exploration may uncover additional reserves.

References:

Doelling, H. H., 1972, Mineral resources of western Box Elder County, Utah: Utah Geol. and Mineral Survey unpublished report.

Heikes, V. C., 1920, History and Production of Park Valley district in Ore Deposits of Utah: U. S. Geol. Survey Prof. Paper 111, p. 497-499.

Hintze, L. F., 1973, Geologic history of Utah: Brig. Young Univ. Geol. Studies, v. 20, part 3, 181p.

Promontory District

The Promontory mining district is located near the southern end of the Promontory Mountains, mostly in T. 6 N., and Rs. 5 and 6 W. The mining district was discovered much later than most of the others of the state. It has produced more than 14,000 tons of oxidized zinc and zinc-lead ore making it the third largest zinc producer in the state (Heyl, 1963, p. B38). This ore yielded 6,546,000 pounds of zinc, 1,818,000 pounds of lead, 3,878 pounds of copper, 893 ounces of silver and 3 ounces of gold having a value of $950,321 at the time of production (Stowe, 1975, p. 45). The history of the district is summarized as follows:

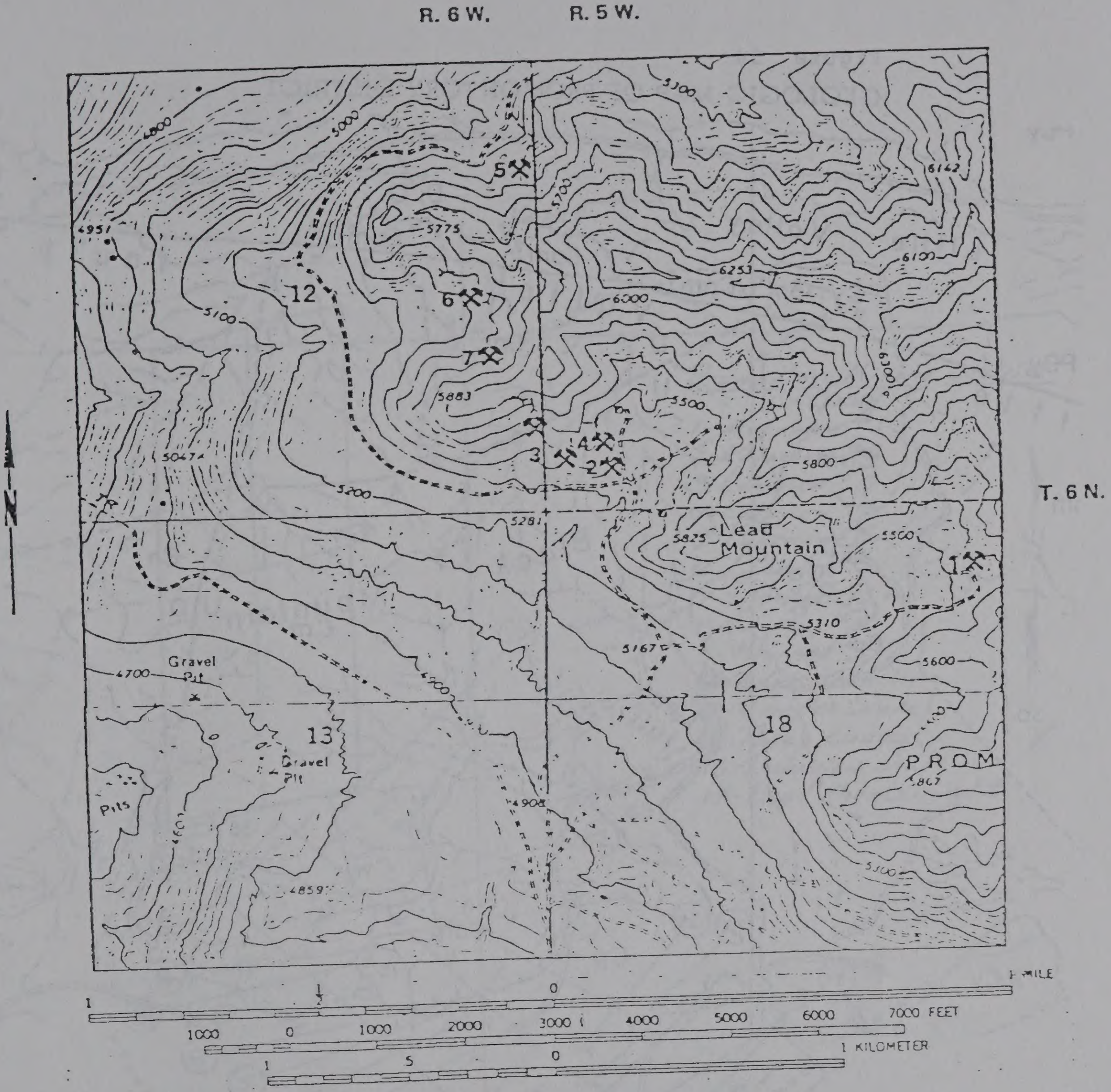
> "Prior to 1914 a few claims were held on a bed of marbleized limestone northeast of Salina. In the latter part of 1914, men doing assessment work on these claims found boulders of lead-zinc carbonate to the northeast. The boulders were traced to outcrop and the deposits were discovered. This led to the formation of the Lakeview Mining Co.,which produced most of the ore of the district. Incomplete production records were kept and reports of dividends paid by the company are not in agreement. The company began development work in April 1915 and by the early part of June of the same year had paid all pre-production expenses and declared a dividend of $2,600 to the five stockholders of the company. Through September, 1916 dividends paid amounted to $150,000. Production tapered after 1918, but occasional small shipments of ore were made by the Lakeview Mining Co. until 1928. Production ceased until World War II when limited production was reported from 1942 to 1947." (Perry, 1975, p. 1-2)

All of the ore deposits with the exception of one in Little Valley are in a limestone-shale sequence between the Cambrian Prospect Mountain Quartzite and the predominantly carbonate sequence above (Marjum Limestone). Olson (1960, p. 235) notes that the "middle limestone bed" referred to by Butler and others (1920, p. 502) and Siegfus (1924, p. 102) is the upper unit of his Burrows Limestone. Recent stratigraphic work has included this unit in what is known as "Dome Equivalent" (Hintze, 1973, Chart 6). There are two types of mineralization: completely oxidized lead-zinc replacement deposits in limestone localized near fissures and faults and copper and lead sulphides in dolomite along fissures and faults--only the former has yielded significant amounts of ore. The ore deposits are principally located along a specific stratigraphic horizon with a narrow thickness and are completely oxidized. No sulfide ore has been observed, although all observers who have inspected the mines maintain that the carbonate ores were derived from the alteration of sulfides. The principal ore minerals are hemimorphite, smithsonite, and cerussite. Considerable iron oxides are present in the ore which generally contain less than an ounce of silver and practically no copper or gold to the ton. The gangue minerals are limonite, hematite, calcite, dolomite, and possibly barite. Most of the ore minerals are highly intermingled with iron oxides and are not easily identifiable with the naked eye. Hemimorphite is the most common zinc mineral, crystals up to 1/16 inch (1-2mm) can be seen in most of the Lakeview workings. The ore of the main Lakeview workings is predominantly zinc with a little lead. There seems to be an increase in the lead content in the lower workings. The workings on Lead Mountain, to the south, are high in lead and low in zinc. The district has been a small, but highly profitable producer of zinc-lead ore in the past. Mine workings contain pockets of high grade oxide ore and larger amounts of lower grade ore. Heyl (1963) reports that some of the thinner beds contain a fairly large tonnage of mineralized material estimated to contain 5-8 percent lead and 5-10 percent zinc.

Lakeview Mines

The Lakeview Mining Co. owns 16 patented claims that lie in an arc starting on the south side of Little Valley and extending south to Volunteer Gulch and then extending southeasterly across Lakeview Ridge, Cedar Ridge Gulch and continuing over Lead Mountain (figures 53, 54, and 55). The holdings of the Lakeview Mining Co. cover all the major workings in the district including Lakeview 1-5, Skyline tunnel, Complex tunnel, Volunteer Gulch workings, Volunteer Gulch incline, Pete's tunnel, Lakeview shaft and Spelter tunnel. The Lakeview No. 1 tunnel portal is located in NWSWSW 7-6N-5W at an elevation of 5,420 feet (1,652m).

The mineralization is a selective replacement of a favorable carbonate bed along a minor structure in the Dome equivalent (Middle Cambrian). Lakeview No. 1 is the most extensive working and was driven to develop the down dip extension of the "middle limestone" or "ribbon bed" and to provide a haulage level for the higher workings. Most of the ore was sent down through stope connections from higher levels and then hand trammed to the portal. This level has about 1,300 feet (396m) of drifts, several winzes exploring the



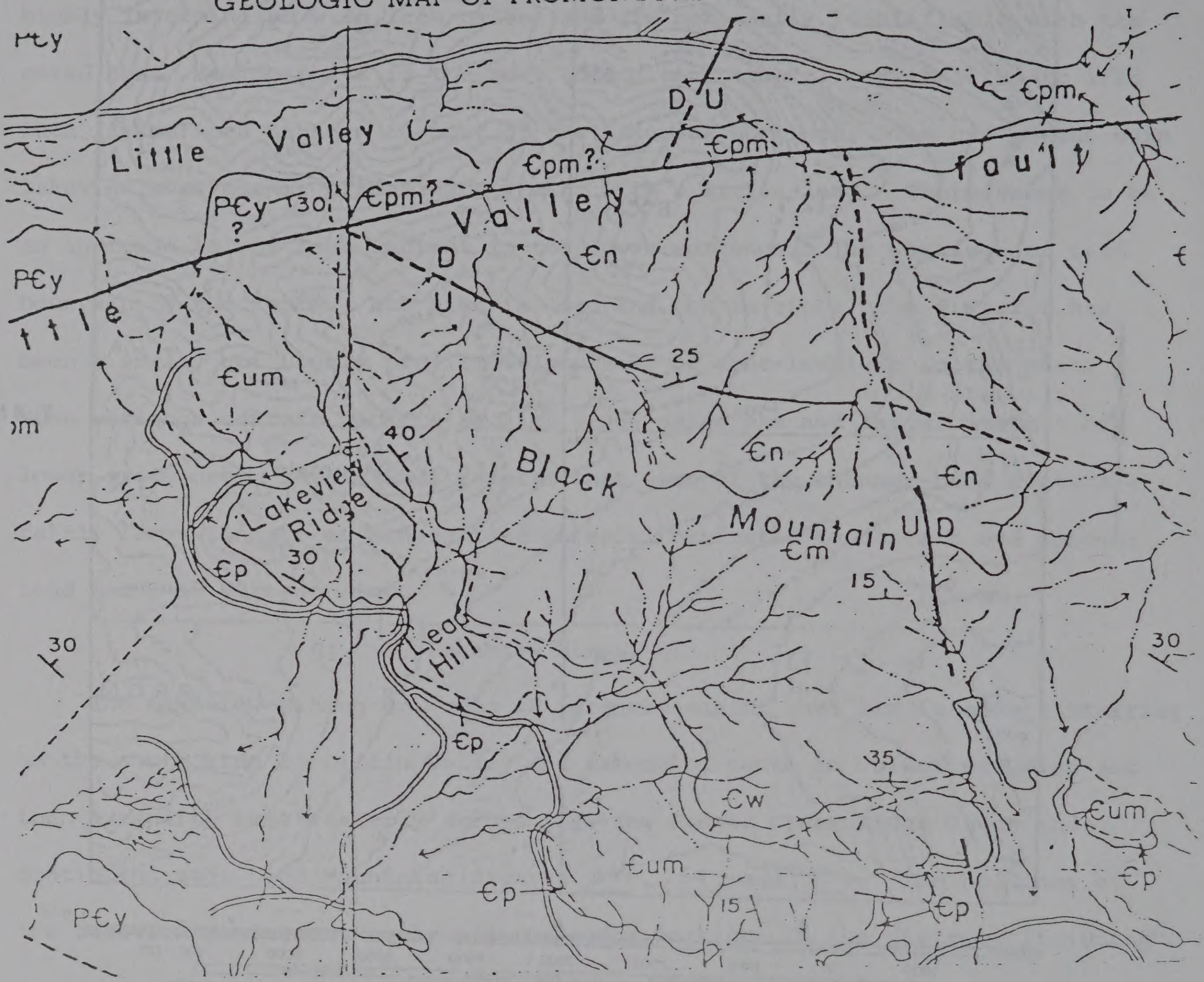
PROMONTORY DISTRICT

1. Big Piney Mining Co. mine
2. Complex tunnel
3. Lakeview mines nos. 1-5
4. Pete's tunnel
5. Spelter tunnel
6. Volunteer Gulch incline
7. Volunteer Gulch mine

Figure 53: Topographic map of Promontory mining district

Adapted From: USGS Poke's Point 7½' Quadrangle
USGS Promontory Point 7½' Quadrangle

Figure 54:
GEOLOGIC MAP OF PROMONTORY DISTRICT



Cn-Nounan Formation
Cm-Marjum Formation
Cw-Wheeler Formation
Cum-Lower Cambrian undifferiented
Cp-Pioche "shale"
Cpm-Prospect Mountain Quartzite
PCy-Precambrian

Adapted from Olsen, 1960

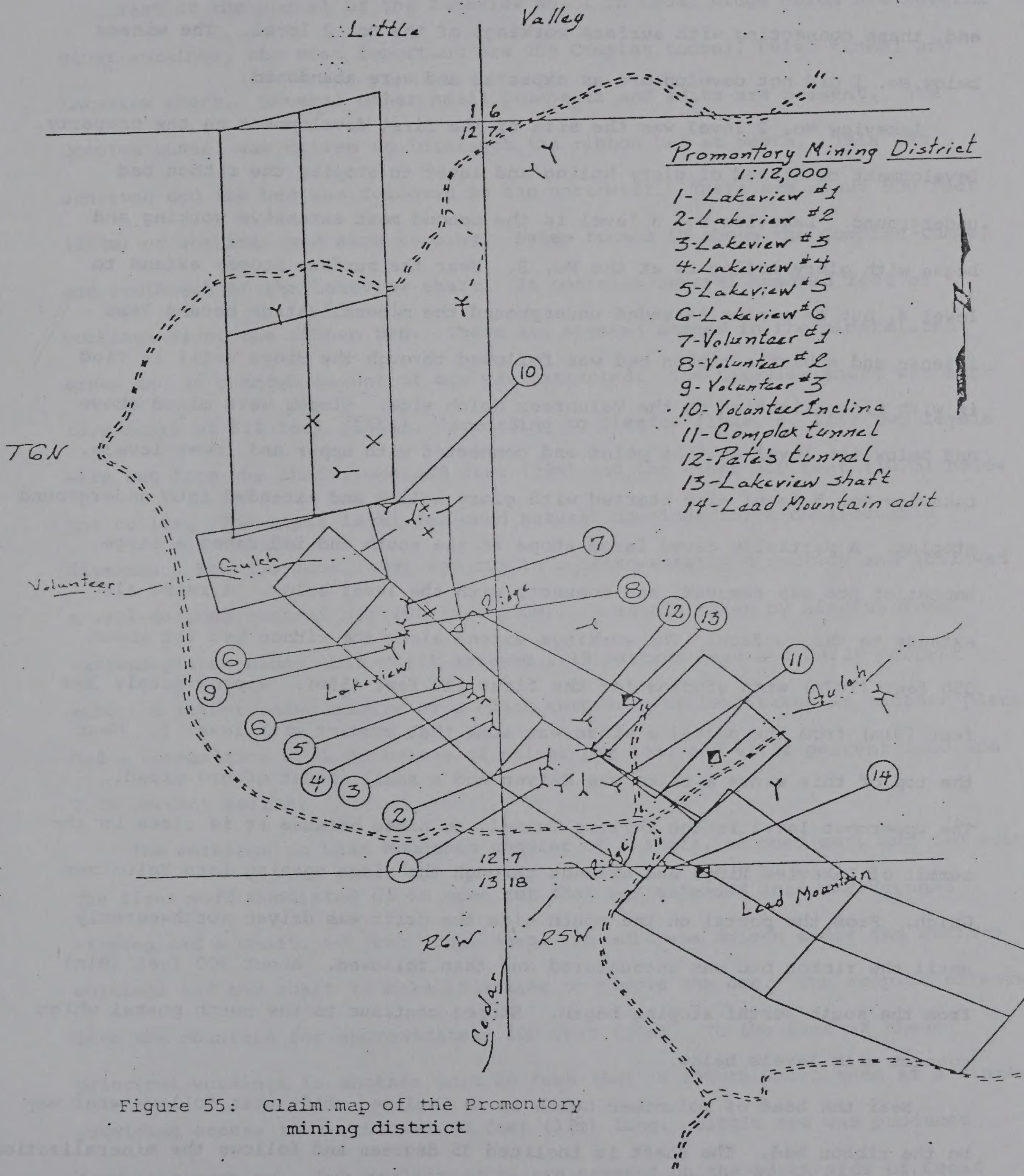


Figure 55: Claim map of the Promontory mining district

down dip extension of the favorable horizon and raise connections with higher level. Two raises connect with workings on the Volunteer Gulch side of Lakeview Ridge. Most of the stoping on the No. 1 level was done near the southern end, these connecting with surface workings of the No. 2 level. The winzes below No. 1 did not develop ore as expected and were abandoned.

Lakeview No. 2 level was the site of the first development on the property. Development consisted of glory holing and later to stoping the ribbon bed underground. Lakeview No. 3 level is the second most extensive working and began with glory holing as at the No. 2. Near the surface stopes extend to level 4, but as mining extended underground the mineralization became less intense and a barren ribbon bed was followed through the ridge until it tied in with mineralization on the Volunteer Gulch side. Stopes were mined above and below the level at this point and connected with upper and lower levels. Lakeview No. 5 level also started with glory holing and extended into underground stoping. A partially caved large stope at the south end indicates a large amount of ore was removed, and connects with the level below. A raise also extends to the surface. The workings extend along the ribbon bed for about 350 feet (107m) with stoping for the first 180 feet (55m). Approximately 300 feet (91m) from the portal a winze was sunk that connect with level 3. Near the top of this winze a raise was driven and a small amount of ore mined. The uppermost level is the Skyline Tunnel, so named because it is close to the summit of Lakeview Ridge and extends through the ridge opening into Volunteer Gulch. From the portal on the south side the drift was driven northwesterly until the ribbon bed was encountered and then followed. About 300 feet (91m) from the south portal stoping began. Stopes continue to the north portal which connect with levels below.

Near the head of Volunteer Gulch is an inclined shaft that follows what may be the ribbon bed. The shaft is inclined 35 degrees and follows the mineralization. Two levels have been turned from the incline to the southeast, the longest one about 110 feet (34m) long. No large amount of ore appears to have been produced from this working. Several other small workings, mostly prospect pits, are located in Volunteer Gulch, which are probably cut in the ribbon bed.

East of the portal of the Lakeview No. 1 in Cedar Ridge Gulch are several other workings, the most important are the Complex tunnel, Petes tunnel and Lakeview shaft. Several other small prospects and adits are present. The Complex tunnel was driven to intersect the ribbon bed at depth. This was achieved and the bed was followed to the northwest. There are about 800 feet (244m) of workings and some stoping. Petes tunnel is above the Complex tunnel and southwest of the Lakeview shaft. It contains several hundred feet of workings along the ribbon bed. There are several stopes in the mineralized areas and an unknown amount of ore was extracted. The Lakeview shaft was sunk to a depth of 512 feet (156m). According to Siegfus (1924, p. 111) two levels were cut from the shaft, one 128 feet (39m) and the other 350 feet (107m) below the collar. The upper level followed natural openings for a considerable distance. The 350-foot level was run in a northwesterly direction and followed a well-defined contact for 100 feet (30m). A sample taken by Siegfus from various places along this drift assayed 1.15 percent lead and 23.28 percent zinc. A rather large sample of a black carbonate of lead taken at another place had a composition of 1.08 ounces of silver per ton, and 41.52 percent lead and 0.36 percent sulfur.

The workings on Lead Mountain consist of a shaft, an open cut, and two adits. The first work consisted of an open cut that was extended into underground stoping and a shaft, 50 feet (15m) deep. An adit was driven under the surface workings and the shaft to make it easier to remove the ore. The stoping extends into the mountain for approximately 100 feet (30m). To the east of these principal workings is another adit 20 feet (6m) in length which ends at a winze providing access to a sublevel 40 feet (12m) long. Little ore was produced from this working. Two smaller adits are present on the south side of Cedar

Ridge Gulch which show limonite and hematite mineralization.

The Spelter tunnel is on the south side of Little Valley and is the northernmost working. The adit was driven to the south and encountered lead-zinc mineralization. Some stoping was done in the mineralized zone, but the amount of ore produced was small.

Small pockets of high grade zinc ore remain in the Lakeview mines along with significant amounts of low-grade material. Heyl (1963) states that most of the known high-grade ore has been removed from the district but some of the thinner beds contain a fairly large tonnage of mineralized material in thin veins. This material is estimated to contain 5-8 percent lead and 5-10 percent zinc.

Big Piney Mine

The Big Piney mine is in the southern end of the district and is in the SENENE 18-6N-5W at an elevation of 5,550 feet (1,691m). The mine was located not long after the initial discovery in the district, it was worked for a short time and a small quantity of ore was produced. Mine workings consist of two adits, from one a winze was sunk at least 50 feet (15m) deep. Total workings amount to about 300 feet (91m). Mineralization is in Middle Cambrian limestones and consists of alteration and replacement along favorable beds and fractures. Minerals in the mine are hemimorphite, smithsonite, cerussite, hematite, limonite, and calcite. There are no known reserves in the mine.

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Rosebud District

The Rosebud district is located in the southern half of the Grouse Creek Mountains in western Box Elder County and is named after an easterly flowing creek. Mineralization is scattered over a wide area and mines are located in Ts. 9, 10, and 11 N., and in Rs. 16 and 17 W. The principal mining area is 12 miles (19.3km) northeast of Lucin and 5 to 6 miles (8-9.6 km) north of Utah Highway 30 (figure 56).

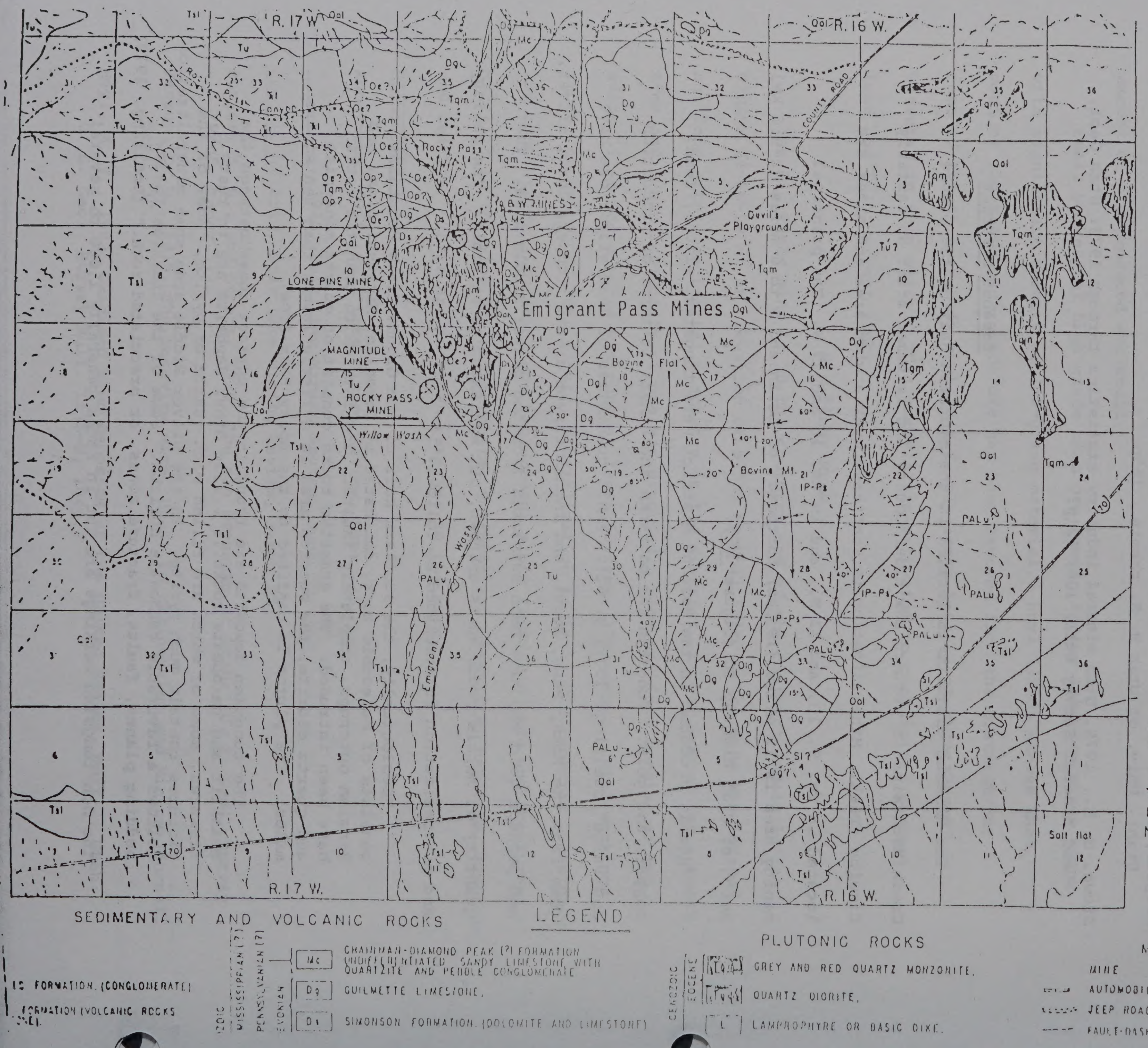
Metals produced in the Rosebud district were tungsten, silver, lead, copper, and gold. Tungsten far outranks the others in terms of production and value (Doelling, 1972, p. 62). Small quantities of lead-silver ore have come from the Rocky Pass, Mogul, and Ingham Canyon areas. Copper, lead, silver, and perhaps gold may have been extracted from the Silver Riddle area. The quantity of metals produced is unknown, but estimated to be small. The geology and mineralization is described as follows:

> "Geologically, the southern half of the Grouse Creek Mountains consists of Paleozoic rock, dominated by Devonian, Mississippian, and Permian outcrops, completely faulted, and into which granitic rocks have been intruded. The granitic rocks consist of quartz monzonite and quartz diorite, the outcrop area is a little larger than ten square miles. The pluton is confined to the Rocky Pass area.
>
> The tungsten deposits are found in the contact zones between the granitic and carbonate rocks... ...The other deposits are in rusty fissures, some of which are filled with quartz or pyrite. Some of the fissures contain much pyrite. In the Silver Riddle area some mineralization follows a favorable carbonate horizon. Some of the fissures follow bedding planes, faults, fracture zones, or brecciated rock." (Doelling, 1972)

The non-tungsten workings are cut in rocks generally 1,000 to several

Rocky Pass Area

Figure 56: Geologic map of southern Grouse Creek Mtns.



Mine or Prospect

(Map after Baker, 1959)

Adapted from Doelling (1972)

thousand feet from the pluton. There are no known reserves of lead and zinc in the district, the Rocky Pass area has the best potential.

Emigrant Pass Mines

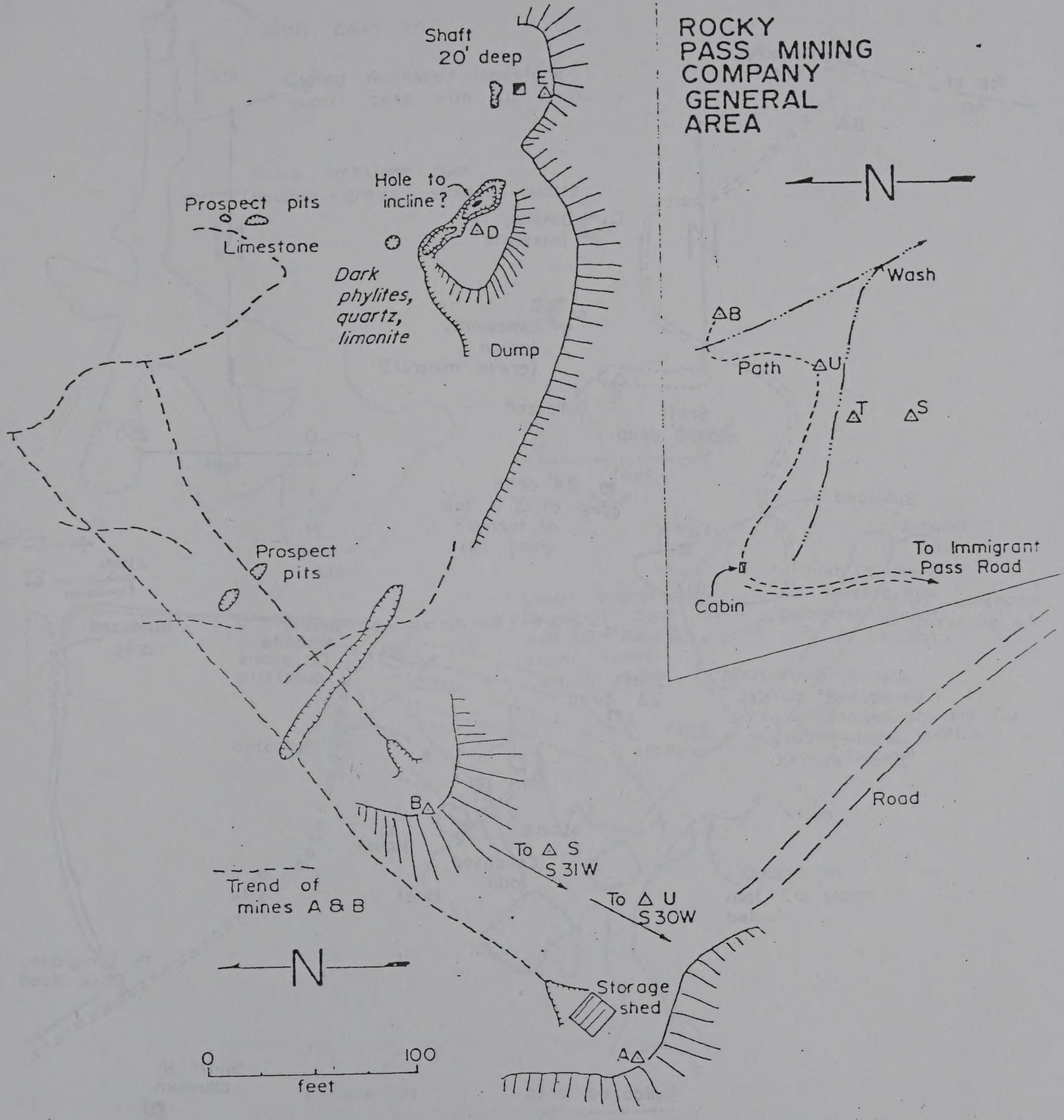
The Emigrant Pass mines are on the north side of the County road about 1 mile (1.6km) west of Emigrant Pass. The principal mine is in SWSENW 12-9N-17W at an elevation of 6,245 feet (1903m). There are no records available pertaining to the mine's history, a small amount of lead-silver ore may have been produced from the mines. The property is claimed by the Rocky Pass Mining Co. There are no reserves in the mine, but additional small ore bodies may yet be found. The mines (figure 57) are described as follows:

> "Host rocks include the Simonson Dolomite, perhaps the Guilmette Formation, and the Mississippian Chainman Shale. Those limestones adjacent to the intrusives are bleached, marbleized and often brecciated. Rusty fissures appear to be the only form of mineralization close to the pluton. The principal workings are about 1000 feet from the contact and cut in limestone, dolomite, and silicified black shale. These consist of two tunnels, the lower with 800 feet of workings, the upper with 250 feet. There are some prospect pits and a 20-foot shaft above in a northwest-trending fissure system. To intersect these appears to have been the objective for the tunnels and this has been done. Mineralization consists of rusty or quartz-filled fissures. What appears to be a dike and sill of intrusive rock is also present in the rear of the principal crosscut. Some scheelite was noted in this part of the working. With this exception no identifiable ore minerals were seen and much of the main tunnel is cut in fresh rock. However, it appears that some ore was taken from small pockets along the fissures in the mine crosscuts and probably consisted of argentiferous cerussite and anglesite. Small specks of pyrite are sometimes noted disseminated in the silicified shale... ...appearances indicate that the claims are intermittently subjected to development work." (Doelling, 1972, p. 66)

Silver Riddle Mines

The Silver Riddle mines lie west of the Emigrant Pass County road, but east of the pass, in NW 21-10N-16W, at an elevation of 5,840 feet (1,780m). Nothing is known about the mines in the literature which were probably staked at the turn of the Century and worked intermittently thereafter. The property is currently held by Pete Toley, Frank Byer, and Roy Houtz. The area contains numerous dozer cuts, prospect pits, and shallow workings (figures 58 and 59).

Two samples, taken across mineralized rock from the K workings, assayed



ROCKY PASS MINING COMPANY AREA
(LEAD—SILVER MINES)

Adapted from Doelling (1972)

Figure 57: Emigrant Pass mines

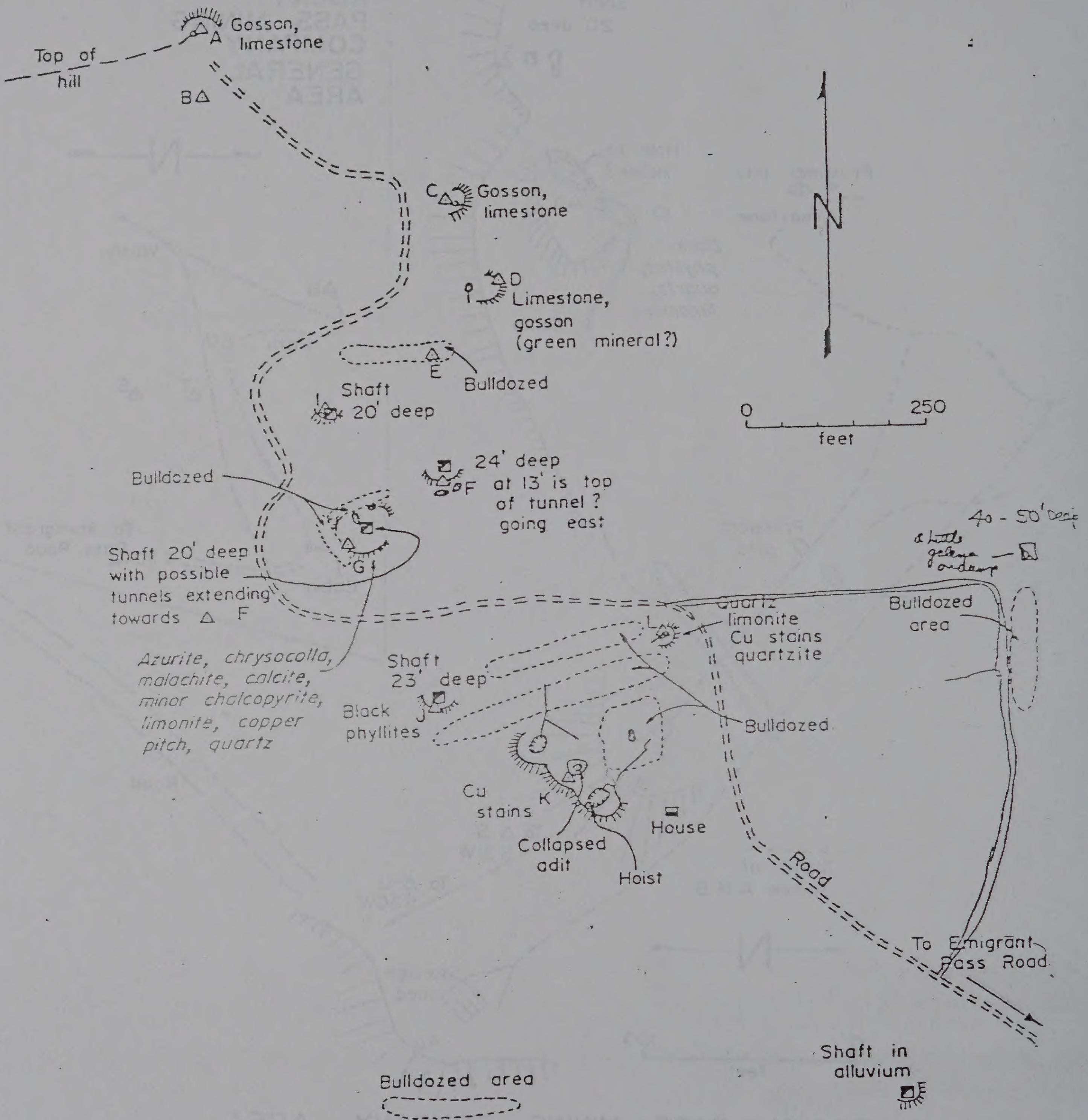


Figure 58: SILVER RIDDLE GROUP

Adapted from Doelling (1972)

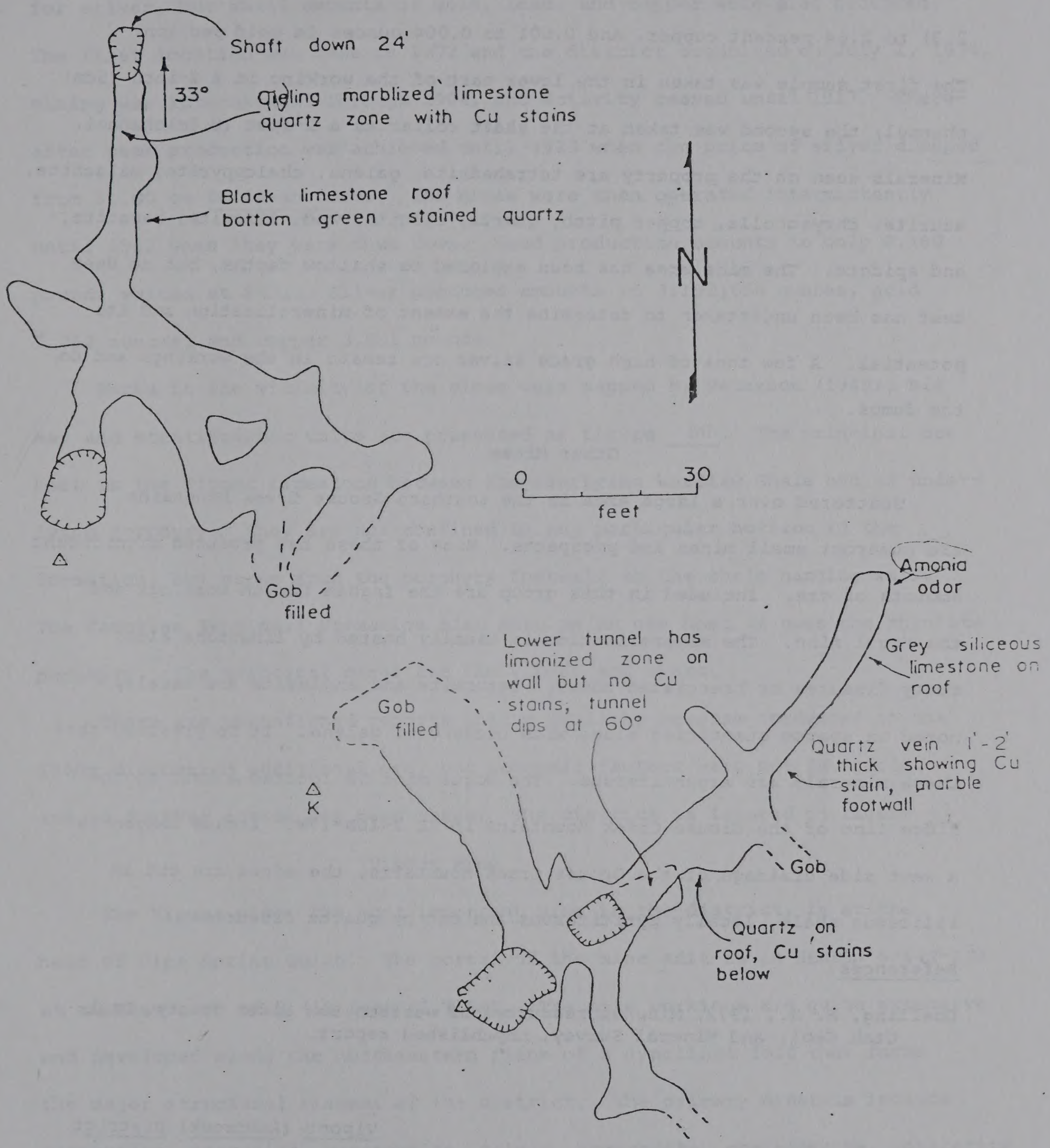


Figure 59:

SILVER RIDDLE GROUP NO. K

Adapted from Doelling (1972)

2.4 to 2.8 percent lead, 0.20 to 0.23 percent zinc, 38 to 43 ounces in silver, 2.31 to 2.64 percent copper, and 0.001 to 0.004 ounces in gold per ton. The first sample was taken in the lower part of the working in a 2-inch (5cm) channel; the second was taken at the shaft collar as a 2-foot (0.6m) channel. Minerals seen on the property are tetrahedrite, galena, chalcopyrite, malachite, azurite, chrysocolla, copper pitch, quartz, calcite, wad, limonite, hematite, and epidote. The mine area has been explored to shallow depths, but no deep test has been undertaken to determine the extent of mineralization and its potential. A few tons of high grade silver ore remain in the workings and on the dumps.

Other Mines

Scattered over a large area in the southern Grouse Creek Mountains are numerous small mines and prospects. None of these has produced significant amounts of ore. Included in this group are the Ingham Canyon workings and the Mogul mine. The mineralization is usually hosted by limestone along rusty fissures or brecciated zones. Cerussite and anglesite are usually noted in sparse quantities along with occasional galena. It is presumed that these minerals are argentiferous. The Mogul mine is located almost on the ridge line of the Grouse Creek Mountains in SE 2-10N-17W. Ingham Canyon is a west side drainage of the Grouse Creek Mountains, the mines are cut in siliceous shale, locally pyritiferous and cut by quartz fissures.

References:

Doelling, H. H., 1972, Mineral resources of western Box Elder County, Utah: Utah Geol. and Mineral Survey, unpublished report.

Vipont (Ashbrook) District

The Vipont or Ashbrook district is located in the northwest corner of Box Elder County at the north end of the Grouse Creek Mountains in a northwest branch called the Vipont Mountains. The district is 10 miles (16km) east of the Nevada border, 1 mile south of the Idaho border and 29 miles (46.6 km) northwest of Park Valley. The district was developed and mined principally for silver, but small amounts of gold, lead, and copper were also produced. The first location was made in 1872 and the district organized on July 1, 1874. Mining was intermittent through 1904, and activity ceased until 1917. Thereafter peak production was achieved until 1923 when the price of silver dropped from $1.00 to $0.64 an ounce. The mines were then operated intermittently until 1942 when they were shut down. Lead production amounts to only 6,160 pounds valued at $431. Silver produced amounts to 3,192,666 ounces, gold 7,762 ounces, and copper 3,001 pounds.

Rocks in the vicinity of the mines were mapped by Peterson (1942), his map and stratigraphic units are presented as figure 60. The principal ore host is the Vipont Limestone between the overlying Wardlaw Shale and an underlying porphyry. They are not confined to any particular horizon in the formation, but occur from the porphyry footwall to the shale hanging wall. The Cambrian Sentinell Formation also acts as an ore host as does the rhyolite porphyry. The principal mines are the Vipont and Skoro.

There are unconfirmed reports that a drilling program conducted in the 1950s discovered additional ore, but economic factors were not favorable, and no further action has been taken. The district is located on figure 61.

Vipont Mine

The Vipont mine, the most important mine in the district, is at the head of Pipe Spring Gulch. The portal of the mine adit is in SENESW 6-14N-17W at an elevation of 7,410 feet (2,259m). The mine workings are quite extensive and developed along the northeastern flank of a synclinal fold that forms the major structural element of the district. The primary minerals include tennantite, pearceite, pyrargyrite, galena, argyrodite, chalcopyrite, sphalerite, native gold, arsenopyrite, pyrite, rhodochrosite, sericite, and quartz. Alteration product minerals include argentite, covellite, chalcocite, cerussite, an intermediate between galena and argentite, an undetermined lead-silver salt, and

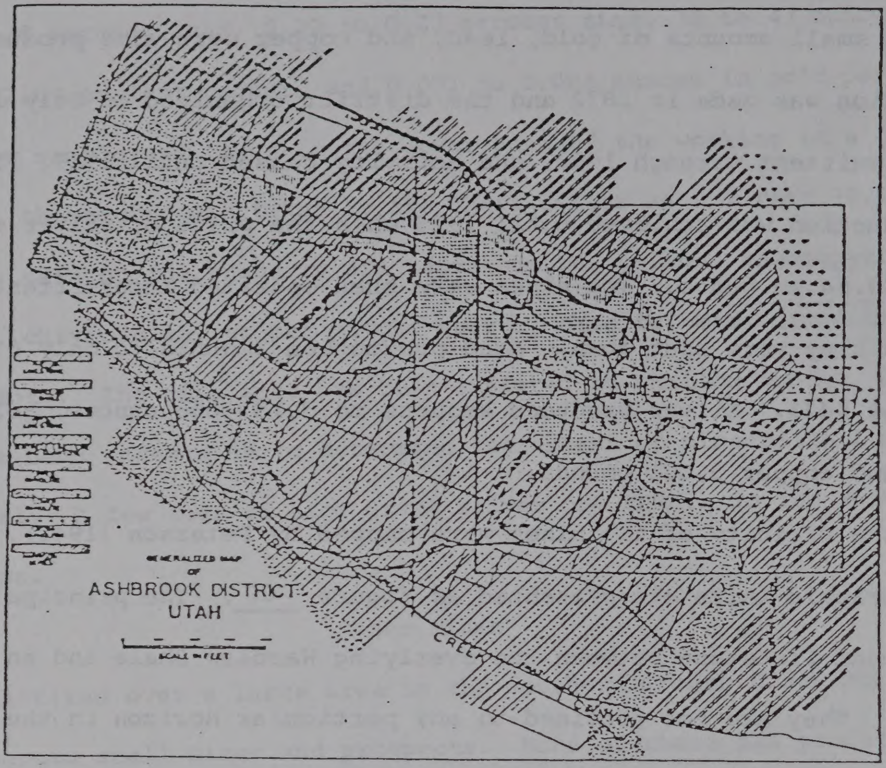


Figure 60: GENERALIZED STRATIGRAPHIC SECTION OF ASHBROOK DISTRICT.

Age.		Formation.	Thickness.	General Lithologic Character.
Paleozoics	Carboniferous (?)	Phelan limestone	1,000–1,500	Coarse to finely crystalline, light blue-gray, massive bedded limestone, locally cherty.
		Wardlaw shale	400	Black to gray, thin to massive bedded, pyritic shale, locally containing lenses of gray dolomitic limestone.
		Vipont limestone	50–100	Fine-grained, crystalline, blue-gray limestone, locally containing numerous small calcite stringers.
	Cambrian (?)	Sentinell limestone	50–100	Light gray, medium grained, crystalline, thin-bedded limestone, usually broken and containing numerous calcite stringers.
		Sentinell quartzite	100–100	White to tan, sucrose quartzite.
Pre-Cambrian	Harrison Series	Upper?	300–400 500–1,000	Usually light gray, contorted and fractured limestone and marble. Massive, white to pinkish, somewhat schistose, vitreous quartzite.
		Middle?	400–600	Fractured and contorted limestone (with mica and marble) interbedded with slates and quartzite.

Adapted from A study of the geology and ore deposits of the Ashbrook silver mining district, Utah by V.E. Peterson, p.468 &471.

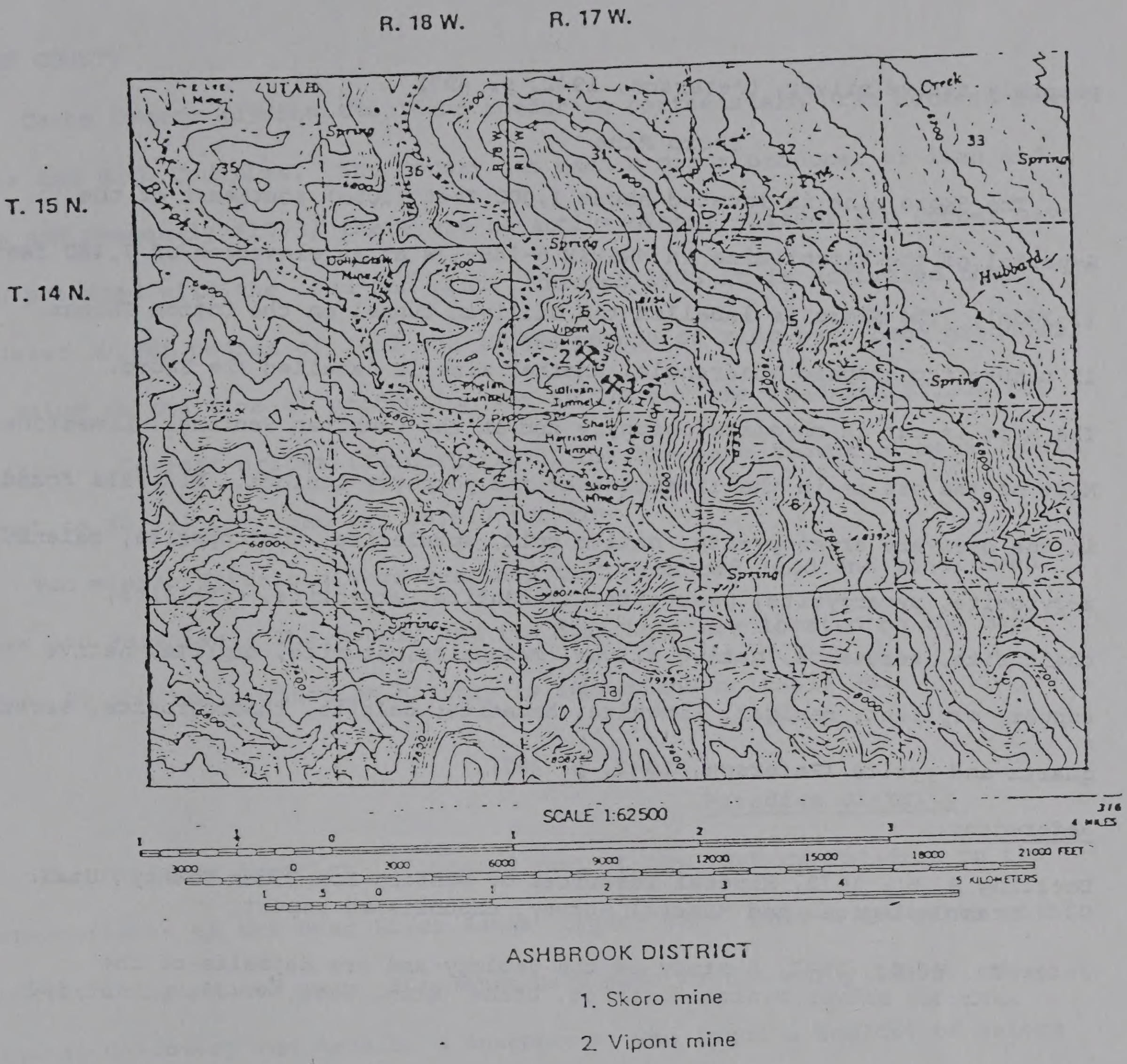


Figure 61: Topographic map of Vipont (Ashbrook) mining district

Adapted From: USGS Cotton Thomas Basin 15' Quadrangle possibly native silver. (Peterson, 1942, p. 497)

Skoro Mine

The Skoro mine is located about 1,000 feet (305m) southeast of the A-portal of the Vipont mine in NWSWSE 6-14N-17W at an elevation of 7,480 feet (2,280m). The Skoro is labelled the Sullivan tunnel on the Cotton Thomas 15 minute topographic quadrangle, another mine is labelled the Skoro. The mine is cut in rhyolite porphyry and in the Cambrian Sentinell Limestone. Most of the ore is in the limestone at the porphyry contact. Minerals found in the ores are arsenopyrite, native gold, sphalerite, chalcopyrite, galena, argyrodite, pyrargyrite, pearceite, tennantite, argentite, covellite, chalcocite, cerussite, native silver, malachite, azurite, cuprite, native copper, orpiment, realgar, limonite, hematite, calcite, rhodochrosite, sericite, quartz and pyrite (Peterson, 1942, p. 497).

References:

Doelling H. H., 1972, Mineral resources of western Box Elder County, Utah: Utah Geological and Mineral Survey, unpublished report.

Peterson, V. E., 1942, A study of the geology and ore deposits of the Ashbrook silver mining district, Utah: Econ. Geol, v. 37, p. 466-502.

CACHE COUNTY

Cache County adjoins the Idaho border in northeastern Utah between Box Elder and Rich Counties. The county has been a minor producer of lead and zinc and presently (1976) there are no active mines. Silver and copper have been produced with the lead and zinc. Through 1976 it is estimated that at least 30,488 pounds of lead and 17,883 pounds of zinc have been produced, the value at the time of production was $1,578 for the lead and $2,324 for the zinc. Current prices (January, 1977) for the same amount of metal would amount to $8,191 for lead and $6,617 for zinc.

Two mining districts were examined that produced lead and zinc; Swan Creek and Paradise. The county and its districts are located on the maps, figure 62 and the production history is summarized on table 16.

Paradise District

The Paradise district is located east of the town of Paradise on the western slopes of the Bear River Range (figure 63). Only a few mines within the district produced ore. Shipments were made in the early 1890s. The original discovery was made by a sheepherder who found a boulder of galena weighing 150 pounds (68kg). High-grade lead-zinc-silver ore with copper and gold showings has been produced.

The district's geology is characterized by a north-trending syncline bounded on the west by a Basin-and-Range type fault system, and on the east by a low angle thrust zone (Heyl, 1963, p. B42). The rocks range in age from the Lower Cambrian Brigham Quartzite to the Mississippian Brazer Formation (figure 64). Limestones and dolomites are the dominant rock types with a few thinbedded sandstones and shales. District reserves are small, some zinc may be recovered by reworking mine dumps.

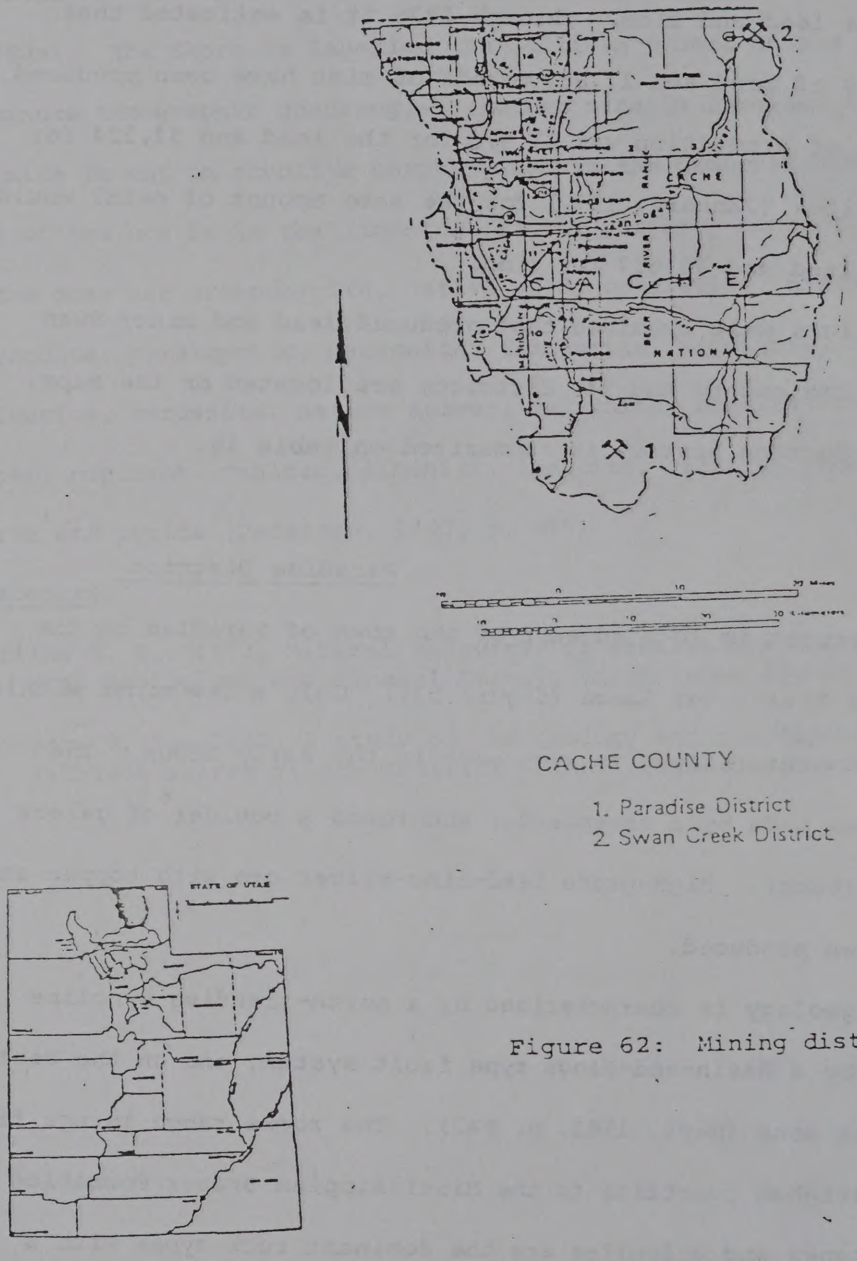
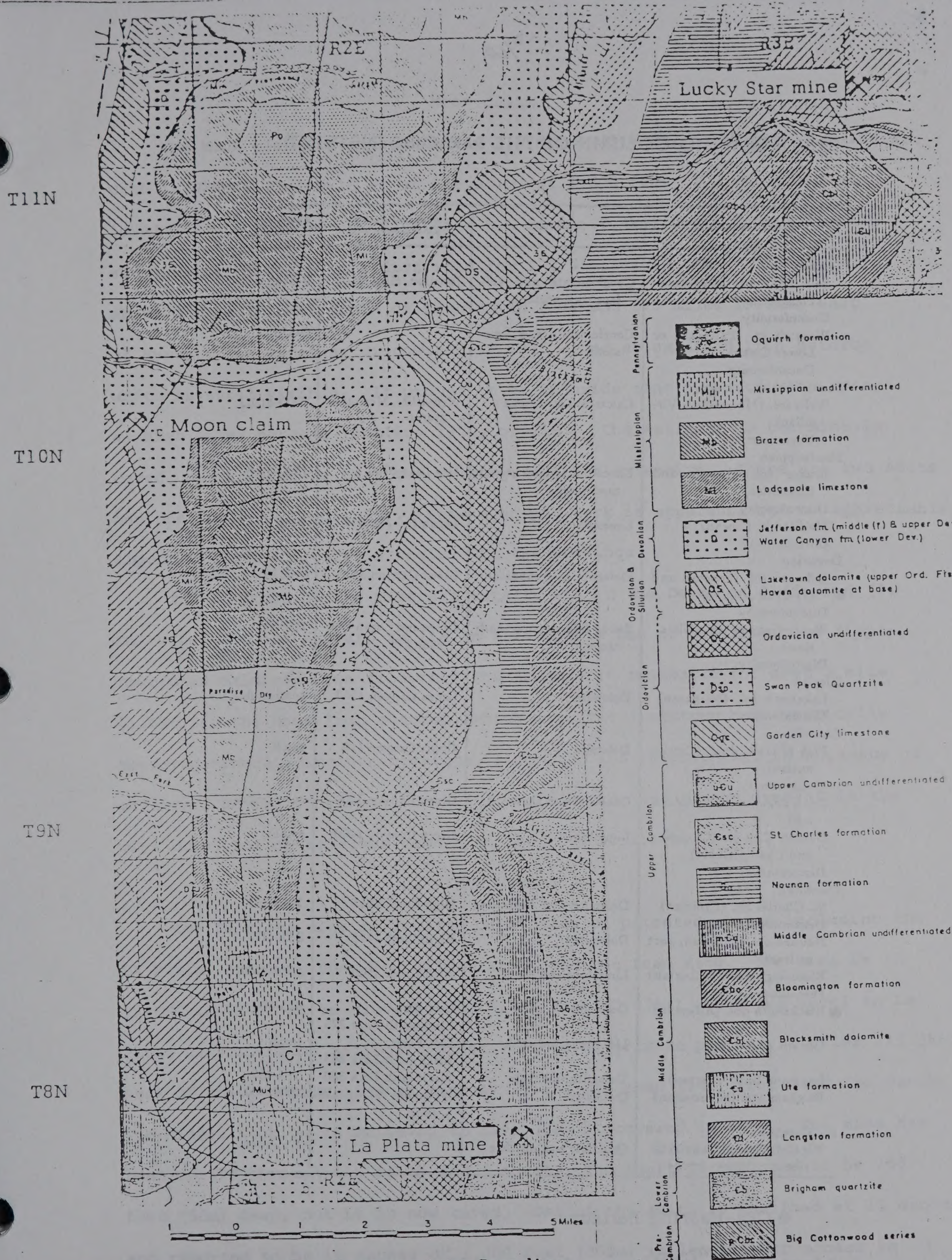


Figure 62: Mining districts of Cache County

Table 16: Production of metals in Cache County, Utah, 1908-1976

Year	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Silver/Ounces	Value	Tons
1908	10,000	---	6,000	1,000	$1,233	500
1909-1913		no production				
1914	9,273	---	305	39	425	10
1915	---	16,895	102	---	2,113	41
1916	9,041	988	5,740	97	2,230	81
1917	---	---	4,717	52	1,331	57
1918	---	---	2,333	17	593	28
1919-1925		no production				
1926	2,174	---	---	2	175	3
1927-1976		no production				
Totals	30,488	17,883	19,197	1,207	$8,100	720

Source: U. S. Bur. Mines Mineral Yearbooks



Location and Geologic Map of the Paradise Mining district from Willaims, (1948)

Figure 63

Figure 64:

STRATIGRAPHIC COLUMN OF THE PARADISE DISTRICT

Formation (Series)	Character	Measured section Thickness in feet	Thickness variation in feet
Tertiary			
Salt Lake gr. (Oligocene-Pleistocene)?	Conglomerate and tuffaceous sandstone	Junction Hills 1160	0–1160+
Unconformity			
Wasatch gr. (Paleocene or Lower Eocene)	Conglomerate and limestone		0–530+
Unconformity			
Pennsylvanian			
Wells fm. (Morrowan—Virgilian)	Calcareous sandstone	Wellsville Mountain 6140+	1000–6140+
Unconformity			
Mississippian			
Brazer fm. (Iowan and Chesterian)	Limestone and calcareous sandstone	Dry Lake 3700	1500–3700
Disconformity			
Madison ls. (Iowan)	Limestone	Logan Canyon 845	small
Unconformity			
Devonian			
● Jefferson fm. (Senecan and (?) Chautauquan)	Dolomite and sandstone	Green Canyon 1840	0–2120
Disconformity			
Water Canyon fm. (Ulsterian)	Sandy dolomite and sandstone	Green and Logan Canyons 540	150–540
Disconformity			
Silurian			
Laketown dol. (Niagaran)	Dolomite	Green Canyon 1510	considerable
Disconformity			
Ordovician			
Fish Haven dol. (Cincinnatian)	Dolomite	Green Canyon 140	small
Unconformity			
Swan Peak fm. (Champlainian)	Quartzite and shale	Green Canyon 340	considerable
Garden City ls. (Canadian and Champlainian)	Limestone	Green Canyon 1400	small
Disconformity (?)			
Cambrian			
St. Charles fm. (Croixian)	Dolomite and limestone	High Creek 1015	1015–1130
Disconformity (?)			
Nounan dol. (Croixian, part at least)	Dolomite	High Creek 1125	825–1125
Bloomington fm. (Albertan)	Limestone and shale	High Creek 1500	1050–1500
Disconformity (?)			
● Blacksmith dol. (Albertan)	Dolomite	Left Fork Blacksmith Fork 325	325–800
Ute fm. (Albertan)	Limestone and shale	Left Fork Blacksmith Fork 665	small
Langston fm. (Albertan)	Dolomite and shale	Blacksmith Fork 380	310–485
Brigham qtz. (Waucobian)	Quartzite	Wellsville Mountain 1800	1800–4800+
Pre-Cambrian			
Big Cottonwood Canyon Series	Quartzite and phyllite		Unknown

● Ore-bearing horizons

Adapted from Williams, 1948, p.1130

Moon Claim

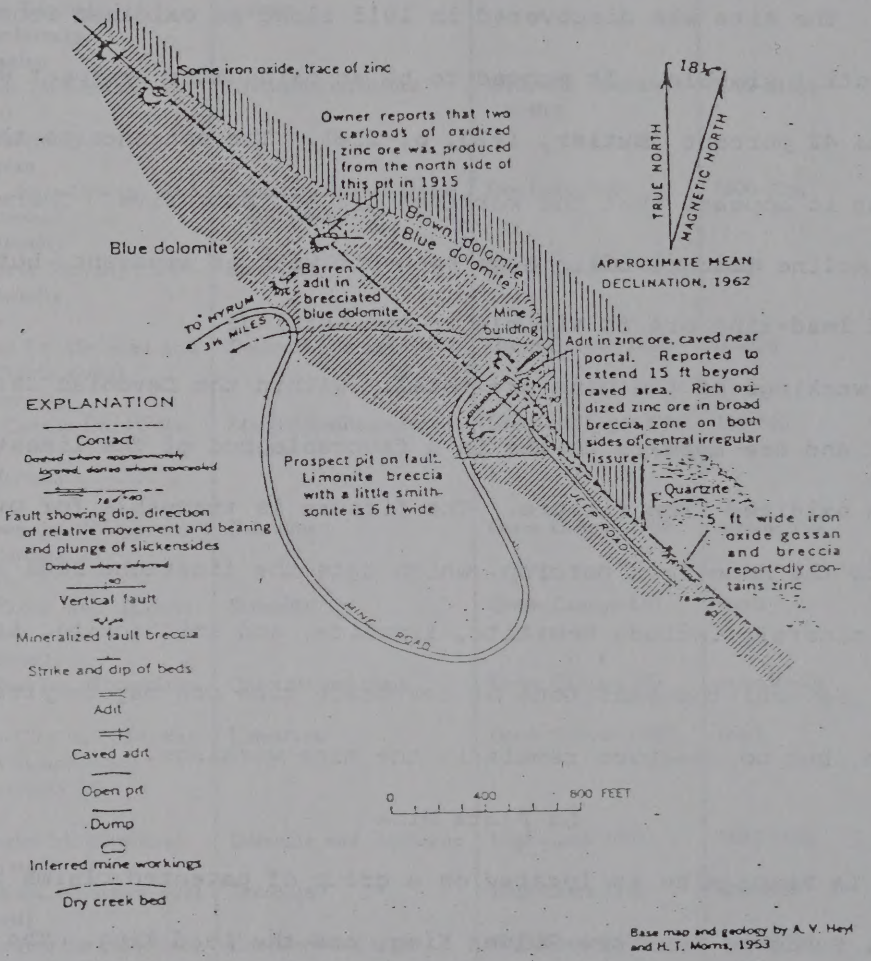
The Moon claim is approximately 3.5 miles (5.6 km) northeast of Paradise, Utah in NWNWNW 13-10N-1E at an elevation of 5,800 feet (1,768m) above sea level. It is reached by travelling 5.2 miles (8.4km) south from Millville and turning easterly on a dirt road for 2 1/4 miles (3.6km). The claim is about 1 mile (1.6km) south of Blacksmith Fork and 3.5 miles (5.6km) east of Hyrum. The site was discovered in 1915 along an oxidized iron outcrop which is still visible. It proved to be an oxide zinc prospect with assays as high as 42 percent (Butler, 1920, p. 218). The entrance to the mine is caved, but it appears that the workings are not extensive. There are two adits and one incline (figure 65). Some open-pit work is apparent, but no appreciable amount of lead-zinc ore is visible in the workings.

The workings of the mine are totally within the Devonian Jefferson (?) Dolomite, and ore appears to lie in a favorable bed of the limestone dipping toward an oxidized iron fissure. The fissure is traceable for over a mile (1.6km) to the Moon Iron outcrop, which cuts the limestone beds vertically. Reported minerals include hematite, limonite, and smithsonite, in a gangue of calcite. Several thousand tons of low-grade zinc ore may be present in the mine dump, but no reserves remain in the mine workings.

La Plata Mine

The La Plata mine is located on a group of patented claims including the La Plata, Sundown, Sunrise, Silver King, and the Lead King. The mine is in SESENE 11-8N-2E at an elevation of 7,480 feet (2,278m) above sea level in La Plata Canyon, Cache National Forest. It is on private property 7 miles (11.3km) west of the junction of Utah Highway 39 and the road (242) from Hardware Ranch. The mineralization is believed to have been discovered in 1891. The mine has been worked through two adits and a shaft. The shaft is reported to be 165 feet (50m) deep, but it is now caved. One of the adits is inclined at 15 degrees and reported to be in excess of 1,000 feet (305m) in length, but access is

MAP OF THE MOON CLAIM


Some iron oxide, trace of zinc
Owner reports that two carloads of oxidized zinc ore was produced from the north side of this pit in 1915
181/2°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1962
Brown dolomite
Blue dolomite
Blue dolomite
Barren adit in brecciated blue dolomite
TO HYRUM 3 1/2 MILES
Mine building
Adit in zinc ore, caved near portal. Reported to extend 15 ft beyond caved area. Rich oxidized zinc ore in broad breccia zone on both sides of central irregular fissure
Quartzite
5 ft wide iron oxide gossan and breccia reportedly contains zinc
JEEP ROAD
MINE ROAD
Prospect pit on fault. Limonite breccia with a little smithsonite is 6 ft wide
EXPLANATION
Contact
Dashed where approximately located, dotted where concealed
Fault showing dip, direction of relative movement and bearing and plunge of slickensides
Dashed where inferred
Vertical fault
Mineralized fault breccia
Strike and dip of beds
Adit
Caved adit
Open pit
Dump
Inferred mine workings
Dry creek bed
0
400
800 FEET

Base map and geology by A. V. Heyl and H. T. Morris, 1953

Figure 65: Map of Moon claim, Hyrum district, Cache County, Utah.

Adapted from Heyl, 1963, p. B-43

limited to 200 feet because of flooding.

The workings of the mine are cut in Middle Cambrian limestone units. Mineralization appears confined to faults and fractures near the surface; ore minerals include galena, malachite, cerussite, and native silver in a gangue of calcite. Galena was found in the surrounding soil and placer mined in the early days and the La Plata is the only placer lead mine in the state. The potential for this property is small.

Lucky Star Mine

The Lucky Star mine is located in SESWSW 14-11N-3E at an elevation of 6,900 feet above sea level. It is reached by the Left Hand Fork of Blacksmith Fork Canyon road to the top of Boulder Mountain followed by a walk of 3/4 mile (1.2km) down Cabin Spring Gully. Little is known about this lead-zinc-silver mine or its production, which is assumed to have been small. The workings consist of several adits and inclines, which are presently partially caved and unsafe for examination.

Ore occurs in fissures and as replacements of limestone in the mine. The Middle Cambrian Bloomington Formation crops out at the mine site and is probably the host rock. Minerals include galena, smithsonite, sphalerite, cerussite, limonite in a gangue of calcite. There is probably little ore left in the mine and its potential is small.

References:

Butler, B. S., and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, p. 217-218.

Heyl, A. V., 1963, Oxidized zinc deposits of the United States, Part 2, Utah: U. S. Geol. Survey Bull. 1135, p. B42-43.

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Salt Lake Mining Review, 1902, The La Plata Consolidated: Aug. 30, p. 18
1904, Development at La Plata: Aug. 30, p. 21
1906, Around the state: No. 15, p. 39.
1911, Comment on Utah mines and prospects, June 15, p.20.

Williams, J. S., 1948, Geology of the Paleozoic rocks, Logan Quadrangle, Utah: Geol. Soc. Amer. Bull. v. 59. n. 11, p. 1121-1164.

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Swan Creek District

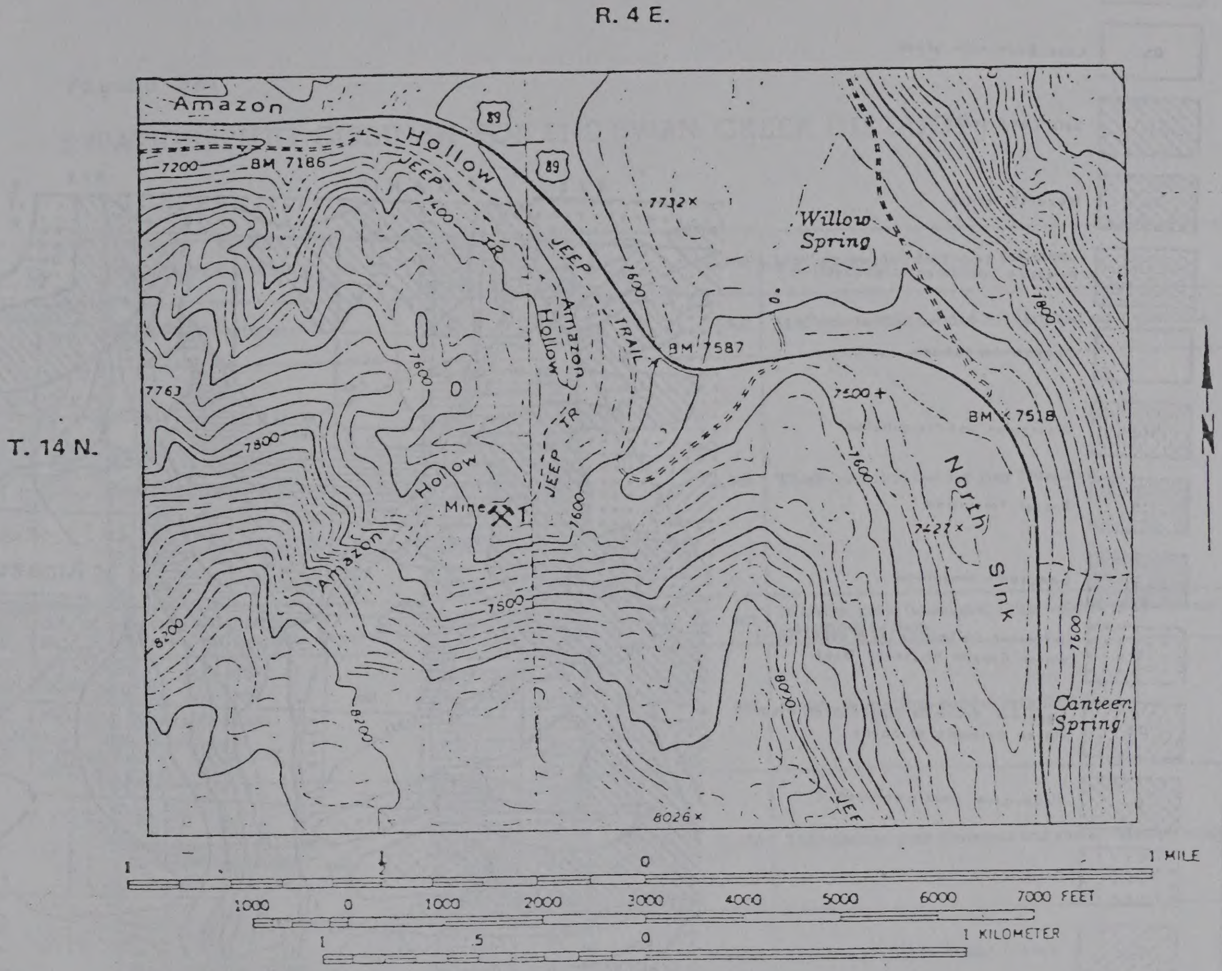
The Swan Creek mining district is located west of Garden City in the northeast corner of the county and extends northward into Idaho (figure 66). The district has only a few scattered mines and prospects in Utah, of which the Amazon is the most important. The district was organized about 1900 and worked on a small scale until the 1920s. Thereafter the area remained idle until 1950 when the Amazon was worked for a short period of time. Production records for the district are unavailable, the amount was minor.

The district geology is characterized by the north-south trending Fish Haven syncline whose axis lies just west of Garden City. The rocks are principally limestones, dolomites, and shales of the Middle Cambrian Bloomington Formation (figures 67 and 68). The tabular ore replacement deposits are generally controlled by faults and fissures. The ore bodies are limited to small patches of near surface sulfide mineralization. Several thousand tons of ore could be mined from the district if the project were economically feasible.

Amazon Mine

This mine is located approximately 8 miles (13km) west of Garden City in unsurveyed NE 21-14N-4E at an elevation of 7,530 feet (2,295m). The mineralization of the mine was discovered in the early 1900s and has been worked intermittently on a small scale. The mine produced a lead-silver-copper ore with some zinc showings. Mine production is unknown and probably has been very small. The workings of the mine are inaccessible due to caved or plugged portals. The workings consist of a shaft, an adit, some trenches and shallow pits.

The workings are cut in the Cambrian Bloomington Formation. Ore is



SWAN CREEK DISTRICT

1. Amazon mine

Figure 66: Topographic map of the Swan Creek mining district

Adapted From: USGS Tony Grove Creek 7½' Quadrangle
USGS Garden City 7½' Quadrangle

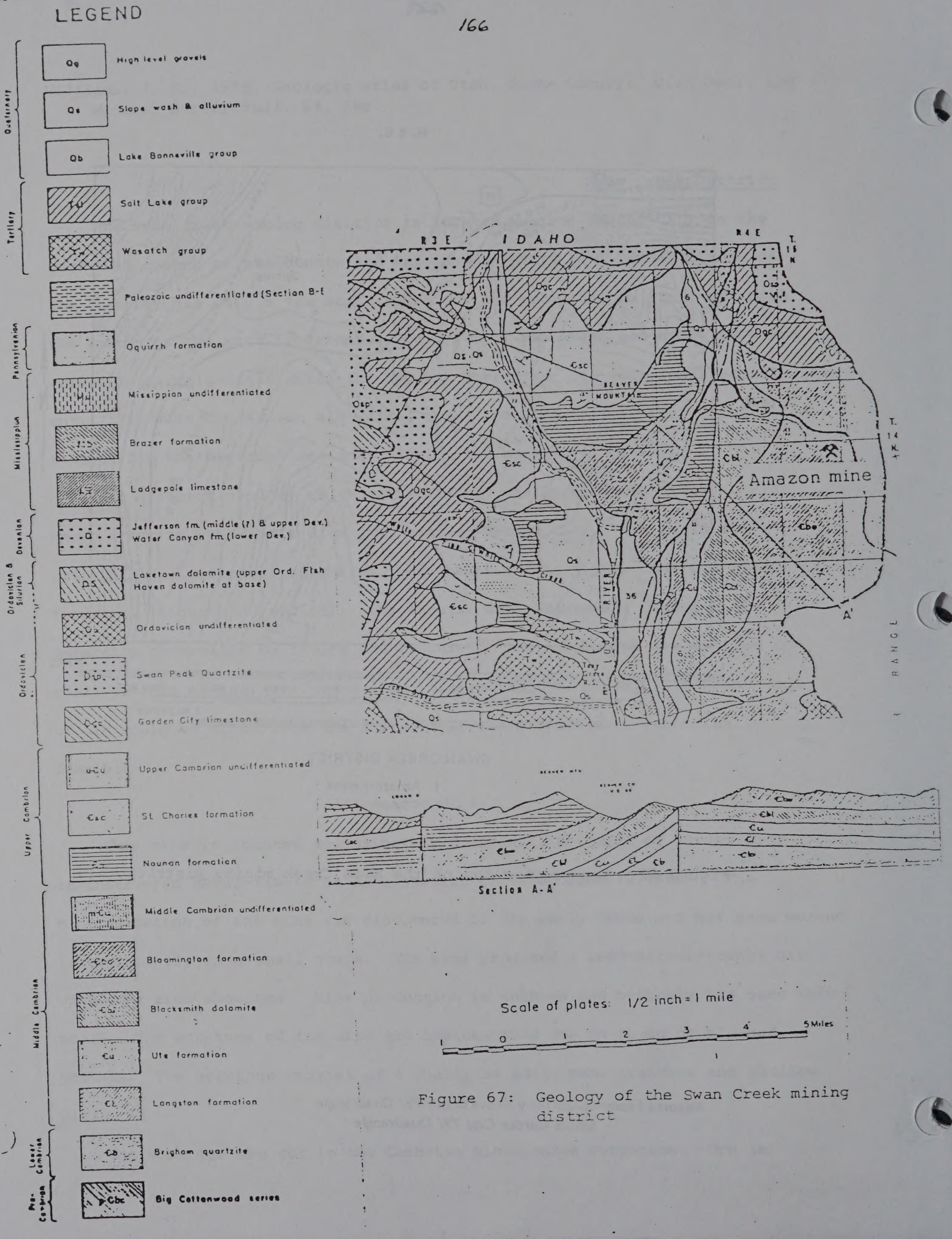
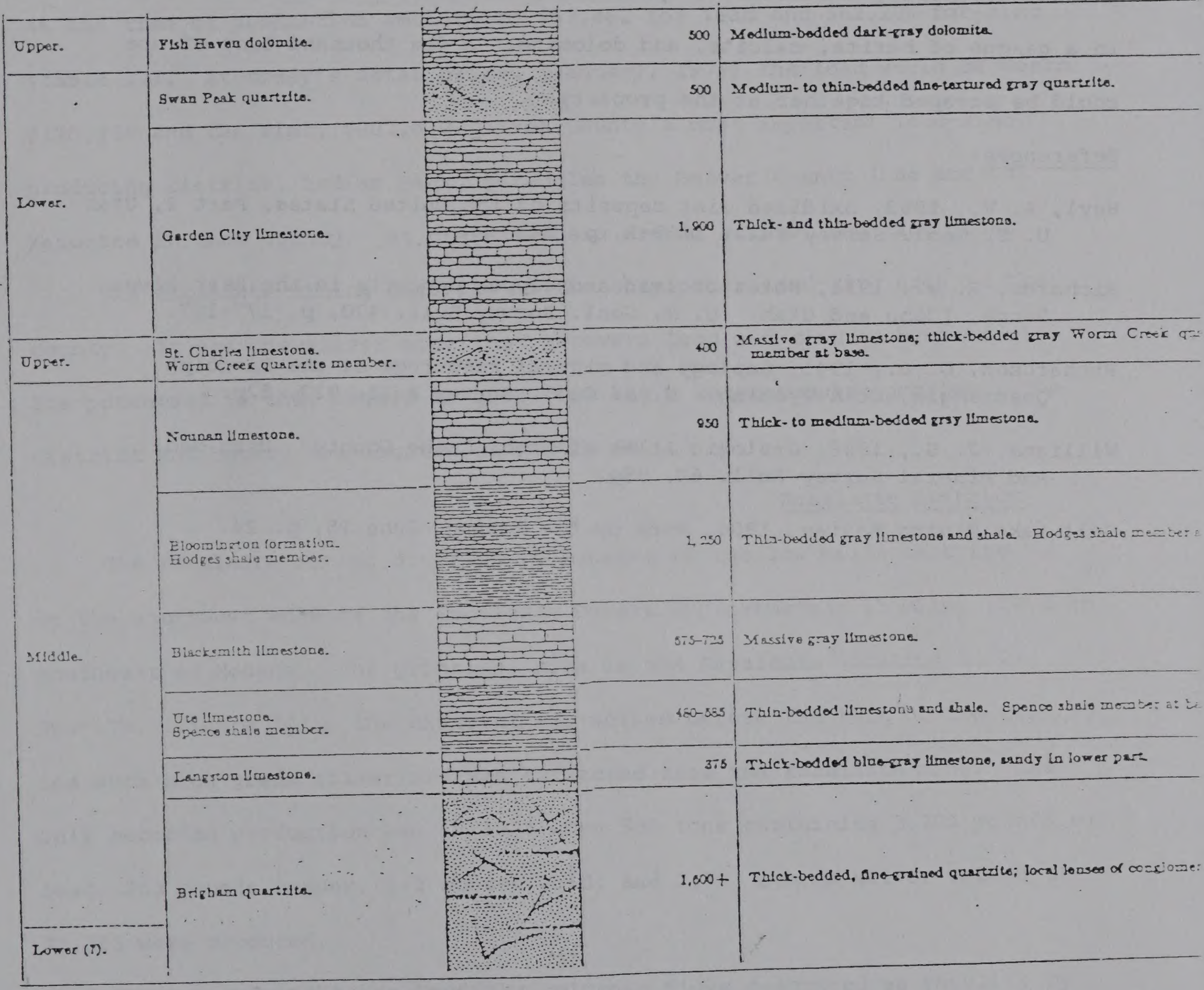


Figure 67: Geology of the Swan Creek mining district

Figure 68:

STRATIGRAPHIC COLUMN FOR THE SWAN CREEK DISTRICT



Ordovician	Upper.	Fish Haven dolomite.	500	Medium-bedded dark-gray dolomite.
	Lower.	Swan Peak quartzite.	500	Medium- to thin-bedded fine-textured gray quartzite.
		Garden City limestone.	1,900	Thick- and thin-bedded gray limestone.
Cambrian	Upper.	St. Charles limestone. Worm Creek quartzite member.	400	Massive gray limestone; thick-bedded gray Worm Creek qu member at base.
	Middle.	Nounan limestone.	950	Thick- to medium-bedded gray limestone.
		Bloomington formation. Hodges shale member.	1,250	Thin-bedded gray limestone and shale. Hodges shale member a
		Blacksmith limestone.	575–725	Massive gray limestone.
		Ute limestone. Spence shale member.	480–585	Thin-bedded limestone and shale. Spence shale member at b
		Langston limestone.	375	Thick-bedded blue-gray limestone, sandy in lower part.
		Brigham quartzite.	1,600 +	Thick-bedded, fine-grained quartzite; local lenses of conglome
	Lower (?).			

Adapted from Richardson, 1941, plate 6

controlled by three structure types: (1) west-northwest striking joints, (2) minor southwest striking joints, and in (3) eastward-trending breccia zones dipping south (Heyl, 1963, p. B41). Ore is found in tabular replacement bodies in limestone around these joints and fractures. Ore minerals include galena, cerussite, smithsonite, sphalerite, enargite, malachite, and azurite in a gangue of barite, calcite, and dolomite. A few thousand tons of ore could be scraped together at the property.

References:

Heyl, A. V., 1963, Oxidized zinc deposits of the United States, Part 2, Utah: U. S. Geol. Survey Bull. 1135-B, p. B41

Richards, R. W., 1911, Notes on lead and copper deposits in the Bear River Range, Idaho and Utah: U. S. Geol. Survey Bull. 470, p. 177-187.

Richardson, G. B., 1941, Geology and mineral resources of the Randolph Quadrangle, Utah-Wyoming: U. S. Geol. Survey Bull. 923, 52p.

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IRON COUNTY

Iron County is located in the southwestern part of the state adjoining Beaver and Washington counties. Through 1976 it is estimated that at least 704,486 pounds of lead and 547,600 pounds of zinc have been produced in the county along with gold, silver, and copper. The value of these commodities at the time of production amounts to $57,462 for lead and $62,286 for zinc (table 17). At today's metal prices (January, 1977) the lead would be worth $190,280 and the zinc, $202,612. Iron County's most important lead-zinc producing district, Indian Peak, straddles the Beaver County line and is reported in that county. At present there are no active lead-zinc mines.

The Escalante mining district is the only other lead-zinc area in the county. It has one silver mine that recovers lead and zinc as by-products. Its potential in this regard is good, but has a water-pumping problem. The district and county are located on figure 69.

Escalante District

The Escalante mining district is located in the low hills that lie on the southwest edge of the Escalante Desert approximately 15 miles (24.1 km) southeast of Modena. The principal mine is the Escalante location in 2-36S-17W. (figure 70). The district was worked before the turn of the Century and much high-grade silver ore was extracted from the Escalante mine. The only recorded production was in 1935 when 500 tons containing 3,700 pounds of lead, 253 pounds copper, 1.2 ounces gold, and 2,983 ounces silver valued at $2,355 were produced.

The exposed rocks are Tertiary volcanic flows described as rhyolite by Heyl (1963, p. B96), but Butler (1920, p. 567) described them as latites and rhyolites with tuffs and breccias belonging to the same series as those of the Gold Springs-Stateline gold mining districts to the northwest. These rocks have been cut by numerous fissures with a north to northeast prevailing strike. A geologic map is provided in figure 71. Ore bodies are fissure fillings in

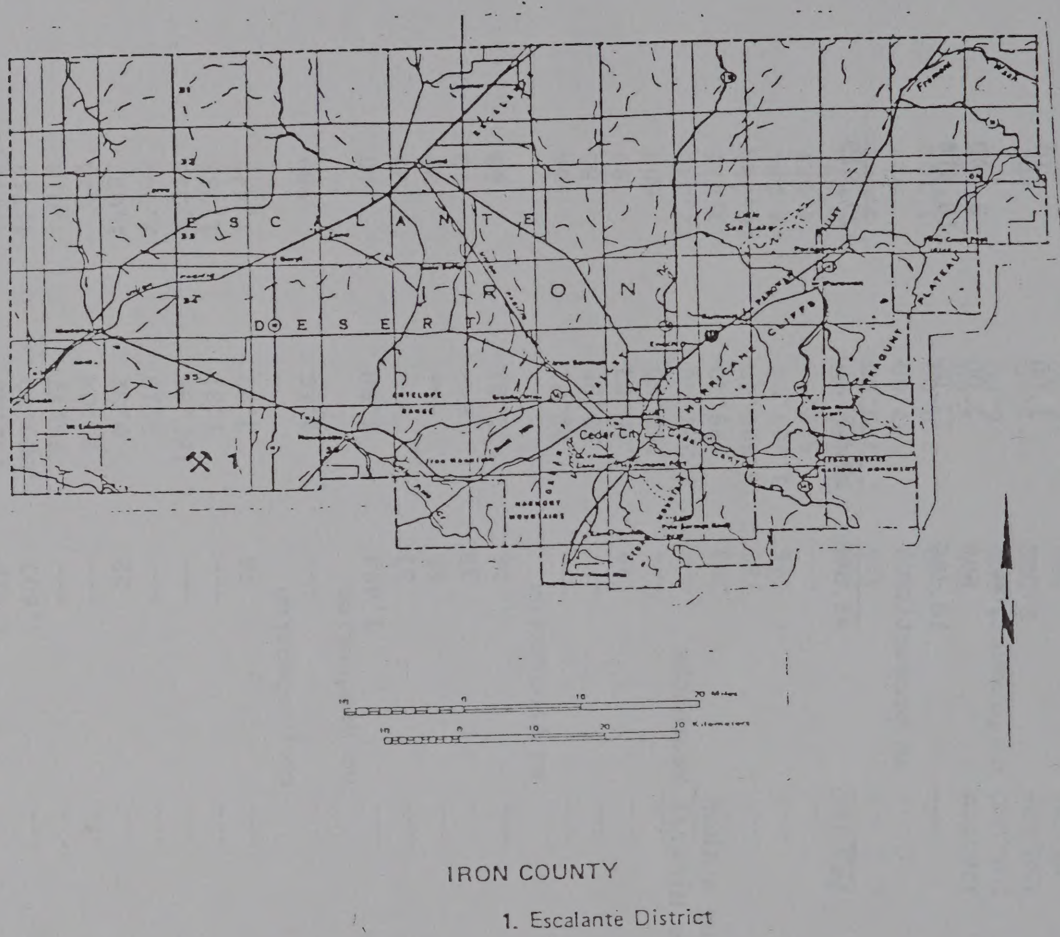
Table 17: Production of metals from Iron County, 1907-1976

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1907	8,430	16,148	---	6,839	1,620.00	1,100	$41,384
1908	10,000	7,404	---	94	2,117.00	7,096	48,525
1909	338	440	---	1,816	162.83	1,345	4,320
1910	4,000	---	---	6,603	1,000.00	4,713	23,986
1911	202	3	---	---	86.79	1,012	2,332
1912	11	5,988	---	---	20.08	314	877
1913	2	---	---	22	0.82	1,037	646
1914	6	---	---	---	2.18	2,200	1,262
1915	867	---	---	---	160.36	3,315	6,164
1916	611	134,573	---	---	1.31	1,751	10,462
1917	449	156,243	---	78	3.92	1,441	14,726
1918-1919				no production			
1920	17	---	---	---	2.66	589	697
1921				no production			
1922	5	2,120	---	1,498	1.98	10	390
1923	30	13,922	---	83	---	33	1,014
1924	23	11,433	---	66	---	26	941
1925	6	3,343	---	38	---	7	301
1926	21	---	---	16	11.85	64	287
1927-1929				no production			
1930	120	---	---	---	22.01	31	467
1931	115	---	---	---	20.85	85	456
1932	38	140	---	70	16.83	99	384
1933	536	---	---	---	160.56	608	3,532
1934	2,842	---	---	---	1,231.70	11,340	50,379
1935	1,385	3,700	---	253	679.40	13,415	33,590
1936	3,902	717	---	185	1,596.60	16,284	68,543
1937	3,835	6,610	---	595	1,267.00	19,086	59,570
1938	1,255	---	---	---	562.00	4,902	22,839
1939	1,884	702	---	461	1,189.00	8,275	47,313
1940	899	9,200	---	425	275.00	3,292	12,474
1941	676	55,700	---	800	37.00	924	5,221
1942	1,558	25,300	---	300	210.00	1,108	9,869
1943	413	50,400	126,500	500	1.00	90	17,606
1944	759	124,900	205,000	3,600	6.00	495	34,410
1945	600	31,500	158,600	2,000	2.00	180	21,416
1946	348	44,000	57,500	500	14.00	307	12,630
1947	45	---	---	---	9.00	73	381

Table 17 continued

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1948	1	---	---	---	1.00	10	$44
1949-1964			no production				
1965	40	---	---	606	2.00	2,748	3,835
1966	212	60,000	---	18,100	77.00	118,414	164,927
1967-1976			no production				
Totals:	46,476	704,486	547,600	45,548	12,571.73	227,819	$728,180

Sources: 1907-1910, rough estimate by author
1911-1976, U. S. Bur. Mines Mineral Yearbooks



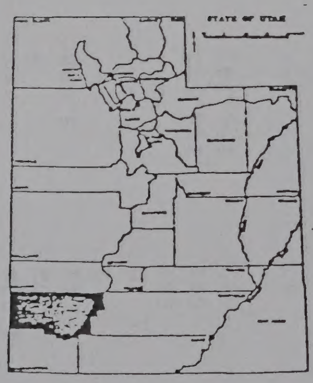


Figure: Escalante mining district and
69 Iron County

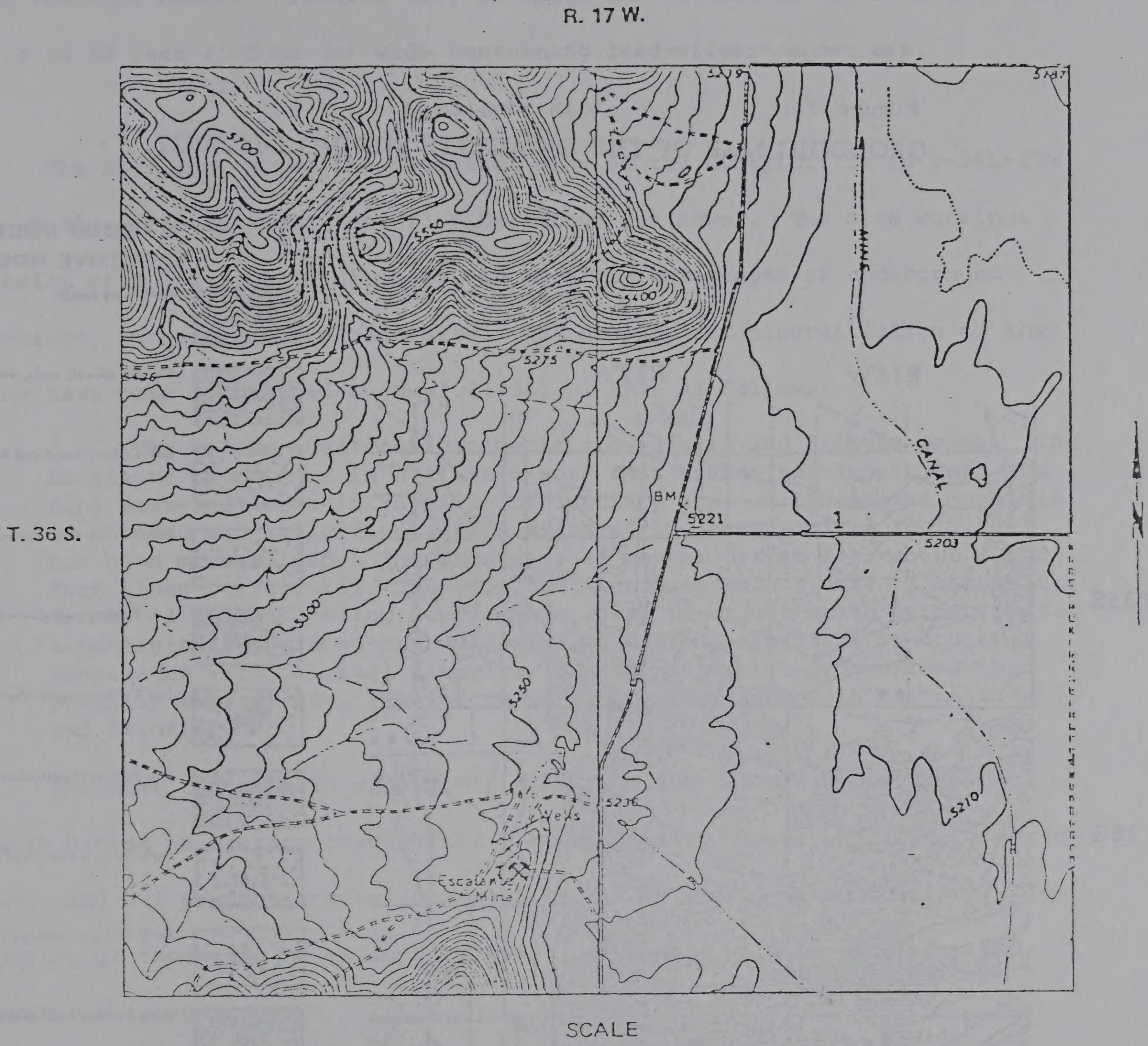
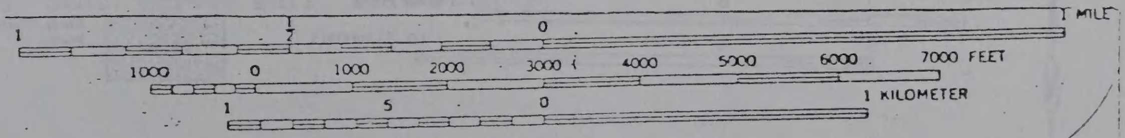


Figure 70: Topographic map of the Escalante mining district

ESCALANTE DISTRICT

1. Escalante mine

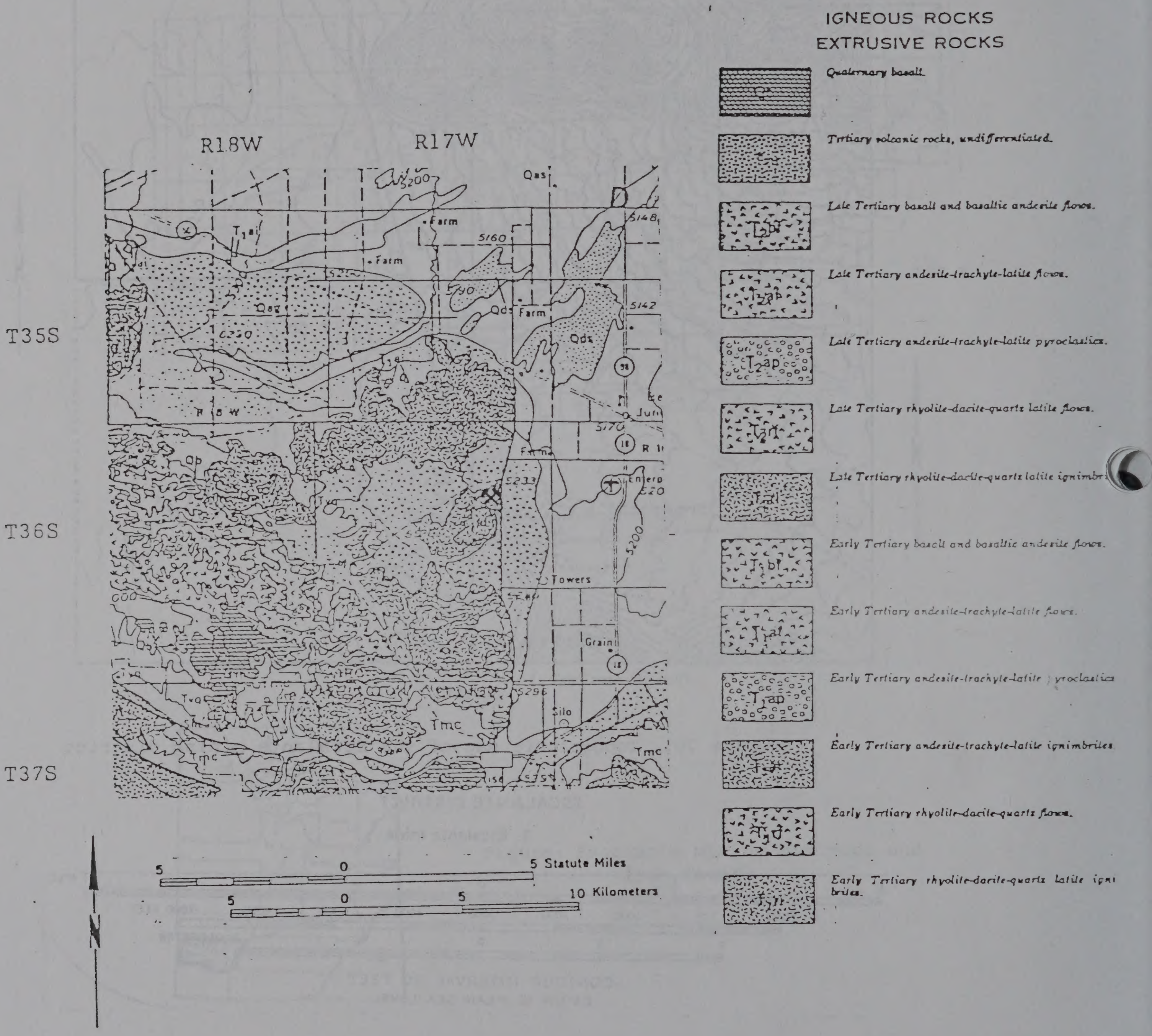


CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

Adapted From: USGS Beryl Junction 7½' Quadrangle

Figure 71:

GEOLOGIC MAP OF THE ESCALANTE MINING DISTRICT


IGNEOUS ROCKS
EXTRUSIVE ROCKS
Quaternary basalt.
Tertiary volcanic rocks, undifferentiated.
Late Tertiary basalt and basaltic andesite flows.
Late Tertiary andesite-trachyte-latite flows.
T2ap
Late Tertiary andesite-trachyte-latite pyroclastics.
Late Tertiary rhyolite-dacite-quartz latite flows.
Late Tertiary rhyolite-dacite-quartz latite ignimbr
T1bl
Early Tertiary basalt and basaltic andesite flows.
T1al
Early Tertiary andesite-trachyte-latite flows.
T1ap
Early Tertiary andesite-trachyte-latite pyroclastics
Early Tertiary andesite-trachyte-latite ignimbrites.
Early Tertiary rhyolite-dacite-quartz flows.
Early Tertiary rhyolite-dacite-quartz latite ignimbrites.
R18W
R17W
T35S
T36S
T37S
5200
Qas
Farm
5160
5148
Farm
5190
Qds
Farm
5142
Qds
6250
Qag
Qp
5170
Farm
Towers
5233
Grain
Silo
5296
Tmc
Tva
Tmc
Tmc
5200
5 0 5 Statute Miles
5 0 5 10 Kilometers
N

Adapted from Geologic Map of Southwestern Utah, 1:250,000 the volcanic rocks. Fissures vary in width and the one at the Escalante mine is 4 to 10 feet (1.2 to 3m) wide containing lead-silver-copper ore.

Escalante Mine

The Escalante mine, the important mine of the district, is in 2-36S-17W at an elevation of 5,285 feet (1,610m) above sea level. The mine workings consist of a 150-foot (56m) shaft, an undetermined length of underground workings, and several prospect pits. The geology and mineralization of the mine have been summarized by Heyl (1936, p. B96) as follows:

> "The widely scattered prospects are on vein and fissure zones. The Escalante deposit is in a fissure zone that trends north-northeast and dips east-southeast in rhyolite of Tertiary age. Although the rhyolite is sheared and silicified over a width of 100 feet, only 4 to 10 feet has been mineralized. The fissure zone can be traced from about 1,000 feet along its strike. The vein contains many thin crusts of cerussite, traces of galena, yellow descloizite, gray to bright-green pyromorphite, annabergite(?), orange-red wulfenite, and green arsenates of copper, associated with calcite, fluorite, quartz, adularia, iron oxides, and possibly cerargyrite. Colloform structures are common in the calcite and fluorite."

The mine contains in excess of a million tons of ore below the water table having an average grade of 12.9 ounces silver, 1 percent lead, 1 percent zinc, and 0.1 percent copper (Samuel Arentz, 1977, oral communication). The pumping of thousands of gallons of water per minute will be necessary to dewater the ore body.

References:

Butler, B. S., and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672p.

Heyl, A. V., 1963, Oxidized zinc deposits of the United States, Part 2, Utah: U. S. Geol. Survey Bull. 1135-B, 104p.

JUAB COUNTY

Juab County has been one of the more important in the state with respect to lead and zinc mining and production, but presently (1976) only the Mammoth mine, in the Tintic district, is active. The period of mining activity in the county extends from the late 1860s and production has been continuous through 1970 with the exception of 1962. The county was inactive in the early 1970s, the Mammoth mine was put back into production in 1976. Through 1970 it is estimated that at least 1,190,330,611 pounds of lead and 130,155,533 pounds of zinc have been produced along with notable quantities of copper, gold, and silver.

Four lead and zinc mining districts were examined and are listed in order of importance and potential: Tintic, Fish Springs, West Tintic, and Trout Creek. Juab County is long and thin and its districts are well-distributed. It is located in the west-central part of Utah between Tooele and Millard counties, a location map is provided as figure 72 and annual production is tabulated in table 18.

Fish Springs District

The Fish Springs mining district is located in the western part of Juab County and the north end of the Fish Springs Range. The district is 58 miles (93km) northeast of Delta and 15 miles (24km) south-southeast of Callao (figure 73). The mountain range contains little timber or vegetation. Water for the area must be obtained from the east side of the range at Fish Springs or from the bottom of the Utah shaft. Mineralized float was found in 1890 on ground that later became the Utah and Galena mines. The discovery led to the organization of the district on March 20, 1891. Through the years the district has produced 17,292,796 pounds lead, 2,800 pounds zinc, 5,366 pounds copper, 508 ounces gold, and 2,658,220 ounces silver valued at $2,507,936 at the time of production (table 19).

The Fish Springs Range is composed of sedimentary and igneous rocks. The sedimentary section ranges in age from the Upper Cambrian Notch Peak Formation

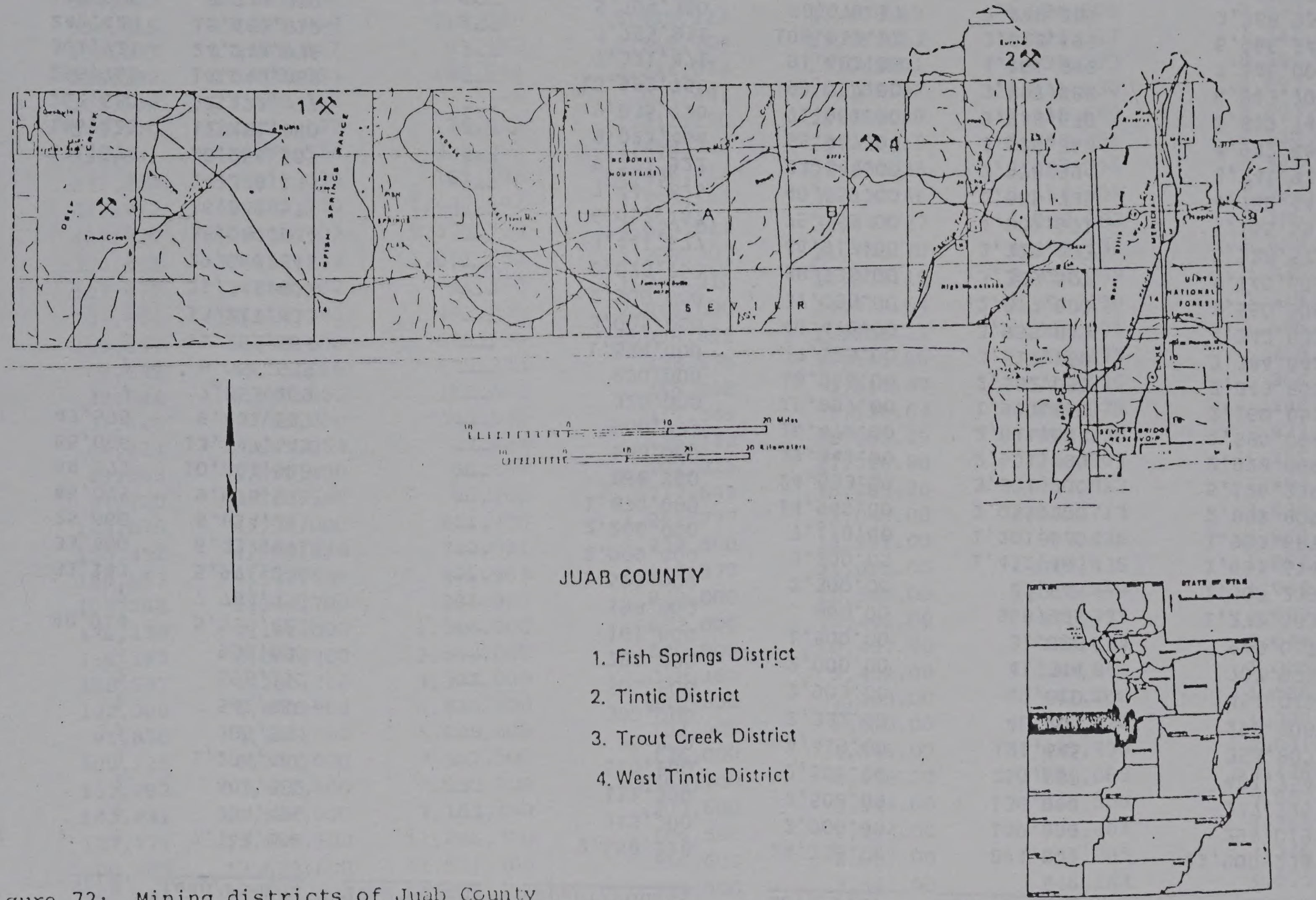


Figure 72: Mining districts of Juab County

Table 18: Production of Metals from Juab County, 1869-1976

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1869-1876	?	7,744,000	---	2,558,228	24,730.00	894,000	$2,900,238
1877	?	294,496	---	313,200	2,000.00	150,000	297,019
1878	?	402,882	---	111,400	2,500.00	130,000	237,776
1879	?	1,206,466	---	110,800	2,500.00	250,000	401,754
1880	?	705,534	---	86,000	4,419.00	181,545	353,807
1881	?	541,810	---	300,000	2,332.00	48,207	295,206
1882	?	598,192	---	505,800	2,903.00	60,010	451,045
1883	?	900,000	---	281,885	2,000.00	41,344	707,971
1884	48,914	5,559,882	---	161,600	1,500.00	31,008	945,037
1885	?	7,784,759	---	198,000	868.00	868,925	1,272,683
1886	32,143	5,971,066	---	1,525,000	2,300.00	47,545	1,308,239
1887	33,800	6,337,991	---	2,000,000	3,200.00	1,412,463	1,991,574
1888	25,660	5,854,261	---	2,200,000	7,110.00	1,201,620	1,903,687
1889	46,075	9,978,559	---	1,870,000	14,940.00	2,055,700	2,882,809
1890	68,177	10,881,908	---	868,960	24,633.00	3,801,700	5,126,238
1891	65,006	13,147,645	---	688,000	19,444.00	2,901,730	2,928,069
1892	47,575	9,431,527	---	966,777	16,470.00	2,011,642	2,580,001
1893	?	7,063,209	---	320,000	15,097.00	1,990,860	2,160,853
1894	?	8,056,635	---	820,000	18,066.00	2,582,033	2,343,907
1895	?	11,283,564	---	1,574,000	27,525.00	3,517,166	3,384,642
1896	?	13,217,833	---	3,005,000	40,470.00	3,955,843	4,247,637
1897	?	21,341,802	---	2,500,000	37,038.00	2,877,600	3,560,508
1898	?	29,060,841	---	2,073,759	38,136.00	3,389,507	4,149,608
1899	?	38,080,904	---	3,441,677	44,917.00	3,329,833	5,228,575
1900	?	36,840,579	---	6,052,157	75,355.00	4,809,971	7,165,551
1901	?	24,388,133	---	7,447,825	40,159.00	2,685,735	4,752,448
1902	131,574	20,266,507	---	5,271,921	33,344.00	2,978,394	3,741,932
1903	186,223	12,481,040	---	8,023,464	65,987.00	3,620,362	4,942,486
1904	262,680	22,122,312	---	9,035,720	71,961.00	3,938,630	5,839,740
1905	266,761	16,049,863	---	10,982,751	99,757.00	3,897,082	6,943,701
1906	301,721	24,249,776	---	7,321,471	91,682.86	4,261,893	7,546,002
1907	242,428	15,489,512	---	7,755,831	108,012.91	3,623,193	6,996,242
1908	142,585	8,723,350	---	5,704,360	58,679.17	2,748,289	3,788,955
1909	183,379	21,532,691	---	5,899,016	70,051.64	3,544,918	4,984,231
1910	242,977	19,647,605	---	9,018,921	57,148.58	3,835,063	5,262,198
1911	301,326	15,015,484	11,359	10,927,100	72,579.87	4,673,698	6,019,651
1912	388,582	19,258,976	776,167	13,339,064	87,309.23	6,638,425	9,008,588
1913	383,977	22,508,439	761,212	9,293,661	67,002.76	5,600,617	7,241,360

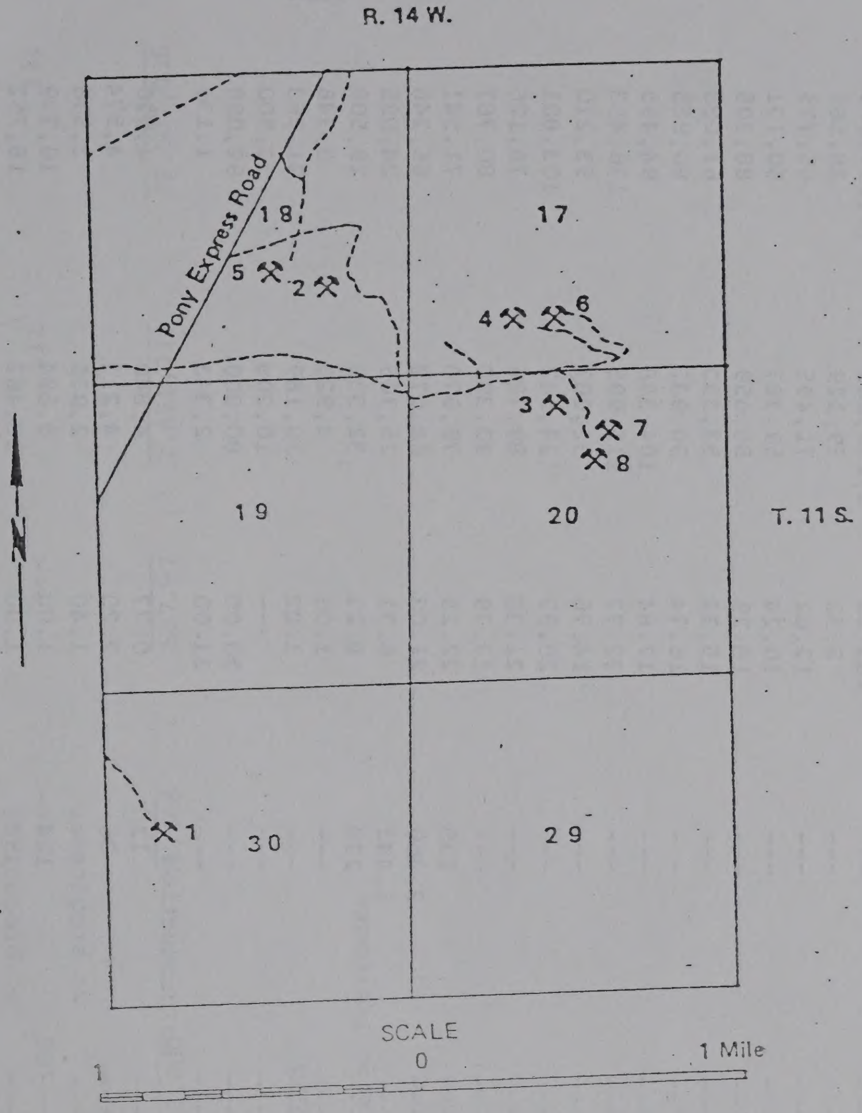
Table 18 continued:

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1914	288,886	32,087,763	264,203	5,285,175	45,137.36	4,480,996	$5,358,980
1915	284,783	29,406,612	2,356,086	5,371,534	44,038.38	4,005,600	5,555,478
1916	352,781	36,563,707	2,477,439	7.124,750	41,431.93	4,892,439	8,696,661
1917	364,360	30,367,586	992,076	9,060,565	40,809.59	4,988,005	10,140,063
1918	304,415	25,823,858	218,061	5,896,223	30,408.19	4,994,806	8,933,104
1919	233,207	17,799,667	93,571	2,560,704	23,953.03	4,822,327	7,322,551
1920	256,292	27,902,353	180,944	2,224,074	27,048.01	4,650,273	8,284,005
1921	203,698	27,186,059	---	821,443	16,105.87	5,031,030	6,693,307
1922	246,910	36,072,127	24,022	1,811,150	21,060.39	6,338,689	9,003,887
1923	251,641	41,995,534	338,359	2,458,706	23,220.15	5,788,396	8,550,613
1924	232,301	35,079,039	162,138	2,436,716	24,602.36	4,285,995	6,516,265
1925	407,492	47,781,770	1,647,642	3,993,591	36,224.46	5,654,551	9,522,409
1926	407,974	50,008,509	8,270,778	4,624,011	31,443.27	5,088,083	9,100,867
1927	300,501	37,452,242	1,051,534	3,209,707	21,768.70	4,165,136	5,658,891
1928	107,477	19,785,802	41,563	1,747,310	12,902.10	2,339,009	3,036,751
1929	207,991	18,014,746	492,803	2,446,000	14,079.64	2,496,199	3,219,476
1930	159,847	9,673,600	686,230	2,096,892	12,501.21	1,561,091	1,646,258
1931	69,739	4,805,266	675,270	928,270	11,545.66	801,175	758,980
1932	32,044	1,046,652	112,464	355,162	6,917.09	229,220	264,798
1933	31,648	785,708	346,522	319,149	7,579.64	193,079	288,314
1934	64,624	2,555,054	17,488	536,312	10,005.29	596,938	873,778
1935	89,063	3,098,400	30,546	702,325	17,226.80	786,503	1,351,810
1936	99,720	3,240,587	96,400	717,641	16,263.20	767,827	1,383,804
1937	149,676	4,794,000	821,400	1,261,777	22,040.00	1,005,713	2,038,231
1938	155,492	4,596,848	730,521	1,239,500	19,521.00	958,436	1,670,821
1939	159,953	5,532,589	426,904	1,119,577	21,825.00	1,029,435	1,861,305
1940	157,268	5,544,700	301,000	943,000	18,349.00	1,012,469	1,764,950
1941	176,170	7,162,000	1,554,000	672,000	10,442.00	871,771	1,589,476
1942	166,193	6,097,000	3,143,000	540,000	10,437.00	720,834	1,644,026
1943	108,597	4,250,200	4,307,000	318,100	5,459.00	519,840	1,386,003
1944	102,008	4,482,900	6,870,500	243,800	2,184.00	442,260	1,565,718
1945	91,876	4,125,000	5,698,400	203,600	1,510.00	421,920	1,390,434
1946	109,225	6,530,000	7,367,500	176,000	1,845.00	455,230	2,071,518
1947	131,292	10,871,500	7,930,000	463,200	4,458.00	771,068	3,476,959
1948	143,841	10,994,000	7,163,400	207,600	3,341.00	911,580	3,907,668
1949	137,771	12,455,500	11,866,300	186,500	2,204.00	772,864	4,252,751
1950	180,809	12,622,600	11,951,700	256,600	2,655.00	881,805	4,346,420
1951	167,682	10,643,000	6,812,300	224,900	3,541.00	846,144	4,025,242
1952	109,743	8,224,000	5,896,000	146,000	2,230.00	610,493	2,968,709

Table 18 continued:

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1953	120,000	7,180,000	4,866,000	204,000	3,141.00	562,667	$2,177,895
1954	119,629	10,482,000	8,662,000	228,000	2,857.00	708,946	3,180,417
1955	104,781	9,428,000	7,996,000	182,000	2,127.00	499,898	2,983,044
1956	80,513	6,302,800	2,248,500	173,300	2,430.00	370,944	1,792,010
1957	45,294	3,050,300	961,200	78,800	1,193.00	159,560	757,576
1958	15,008	794,000	38,000	56,000	723.00	92,846	220,761
1959	2,647	316,000	154,000	34,000	73.00	8,377	74,338
1960	6,422	484,000	216,000	13,000	150.00	10,024	102,545
1961	1,610	96,600	30,531	18,599	11.00	5,992	25,707
1962			no production				
1963	71	800	---	2,000	8.00	1,281	2,813
1964	34,826	---	---	24,000	306.00	18,749	42,776
1965	15,280	4,000	12,000	6,000	83.00	5,772	15,091
1966	1,713	110,000	---	6,000	437.00	26,557	68,241
1967	15,485	---	---	28,000	480.00	29,771	73,381
1968	23,000	16,000	4,000	40,000	667.00	49,650	153,000
1969	25,824	586,000	2,000	56,000	961.00	87,924	312,000
1970	82	1,600	500	300	---	282	996
1971-1975			no production				
1976	?	?	?	?	?	?	?
Totals:	(Incomplete) 11,258,738	1,190,330,611	130,155,533	220,633,001	2,038,088.34	187,415,020	$309,995,840

Sources: 1869-1904, production from Tintic district only (Butler and others, 1920, p. 408-409
1957, production excludes West Tintic district
1961 and 1970, rough estimate
1976, only production was from the Mammoth mine, data held confidential by Kennecott Co. Corp.
1905-1970, U. S. Bur. Mines Mineral Yearbooks.



FISH SPRINGS DISTRICT

1. Cactus mine
2. Early Harvest mine
3. Emma mine
4. Galena mine
5. Joseph adit
6. Utah mine
7. Vulcan mine
8. Wilson mine

Figure 73: Outline map of the Fish Springs mining district

Adapted From: USGS Fish Springs SW 7½' Quadrangle

Table 19: Production of metals from the Fish Springs mining district, Juab County, Utah, 1891-1976

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1891-1898	7,325	5,886,940	---	---	183.12	1,239,269	$1,107,988
1899	341	331,826	---	---	8.52	39,129	38,585
1900	505	480,390	---	---	12.62	71,495	65,725
1901	512	564,809	---	---	10.24	59,387	60,131
1902	923	998,483	---	---	18.29	88,659	88,305
1903	815	761,087	---	---	15.32	53,333	61,083
1904	846	652,806	---	---	16.74	90,932	80,965
1905	892	661,572	---	---	17.84	104,358	94,495
1906	1,161	1,022,205	---	---	22.72	115,995	136,453
1907	663	607,247	---	---	14.76	92,001	93,210
1908	914	885,092	---	---	29.99	124,542	103,801
1909	665	675,039	---	---	21.38	89,726	76,126
1910	729	717,929	---	---	17.79	90,390	80,767
1911	727	637,054	---	235	22.25	79,970	71,541
1912	585	501,252	---	2,360	21.03	68,073	65,246
1913	246	184,879	---	1,442	6.71	25,705	24,025
1914	331	292,754	---	278	8.21	32,339	29,509
1915	31	28,412	---	---	1.05	3,923	3,346
1916	123	115,528	---	---	1.02	20,169	21,263
1917	125	63,824	---	---	---	10,208	13,900
1918-1931	850	610,000	---	---	20.00	80,000	92,000
1932	29	21,228	---	---	21.00	2,343	1,139
1933			no production				
1934	48	36,838	---	12	0.77	4,840	4,520
1935	57	36,650	---	36	2.20	4,213	4,574
1936	47	27,674	---	---	1.40	2,936	3,596
1937	162	68,000	---	124	1.00	8,684	10,779
1938	195	140,674	---	357	1.00	18,462	18,752
1939	66	45,064	---	125	1.00	6,986	6,908
1940	46	33,440	---	97	---	4,777	5,080
1941	27	8,000	---	---	---	997	1,165
1942	51	32,400	---	---	1.00	4,365	5,310
1943	46	24,600	---	100	4.00	4,012	4,851
1944	20	15,500	---	---	---	3,084	3,433
1945	38	18,000	---	---	1.00	2,814	3,584
1946			no production				
1947	24	7,500	---	---	2.00	1,432	2,446

Table 19 continued:

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1948	41	16,000	---	---	1.00	2,107	4,806
1949	4	3,500	200	---	---	610	1,130
1950	43	36,000	2,500	200	1.00	2,570	7,618
1951	19	15,400	---	---	---	1,895	4,379
1952	24	25,800	---	---	---	1,379	5,402
1953-1955				no production			
1956	7	1,400	100	---	---	111	334
1957-1976				no production			
Totals:	20,303	17,292,796	2,800	5,366	507.97	2,658,220	$2,507,936

Sources: 1891-1917, Butler and others, 1920
1918-1931, Rough estimate
1932-1973, U. S. Bur. Mines Mineral Yearbooks

to the Devonian Simonson Dolomite (see figures 74 and 75). The strata are mainly dolomites and limestones although some quartzite and shale are present. The igneous rocks consist of dikes that are rhyolitic to andesitic in composition (Oliveira, 1975, p. 78). The sedimentary rocks were deformed during the Sevier Orogeny, which included folding, low-angle normal faulting, east-west high angle faulting, and high-angle reverse faulting. The main structural feature of the district is an asymmetrical anticline whose axis strikes north to northeast and whose east limb is the steeper. The anticline has been faulted by north-south and northwest-trending normal faults. Oligocene intrusions introduced the mineralizing solutions which formed the ore deposits. Numerous east-west fissures and faults, having small displacements, have furnished channels for circulating ore solutions and are filled with dike rock. The northwest-trending faults are older and have been cut by north-south trending post-mineral faults (Butler, 1920, p. 468).

Mineralization in the district is associated with the fracture zones and a concealed intrusive (Christiansen, 1975). The most intensely fractured zone parallels the rhyolite porphyry dikes and strikes N. 70° W., and is delineated by prospect pits above the portal of the Galena No. 1 adit. Another highly fractured zone is near or along the Juab fault, along which the Emma and Vulcan mines lie. A mineralized area that may contain ore-grade material is north of the Joseph adit portal in the concealed intrusive beneath the alluvium. The mineralization consists of altered copper shows that are currently (1976) being explored by Utah International, Inc.

The main ore bodies are aligned along east to southeast-trending fracture zones along which the mines have been located. Ore is a replacement of carbonate rocks and is oxidized in the upper mine levels. The high silver content has allowed for transportation of the ore to distant shipping points. The primary ore has been oxidized to cerussite, anglesite, plumbojarosite, ruby silver, calamine, smithsonite, hydrozincite, aurichalcite, willemite(?), wulfenite,

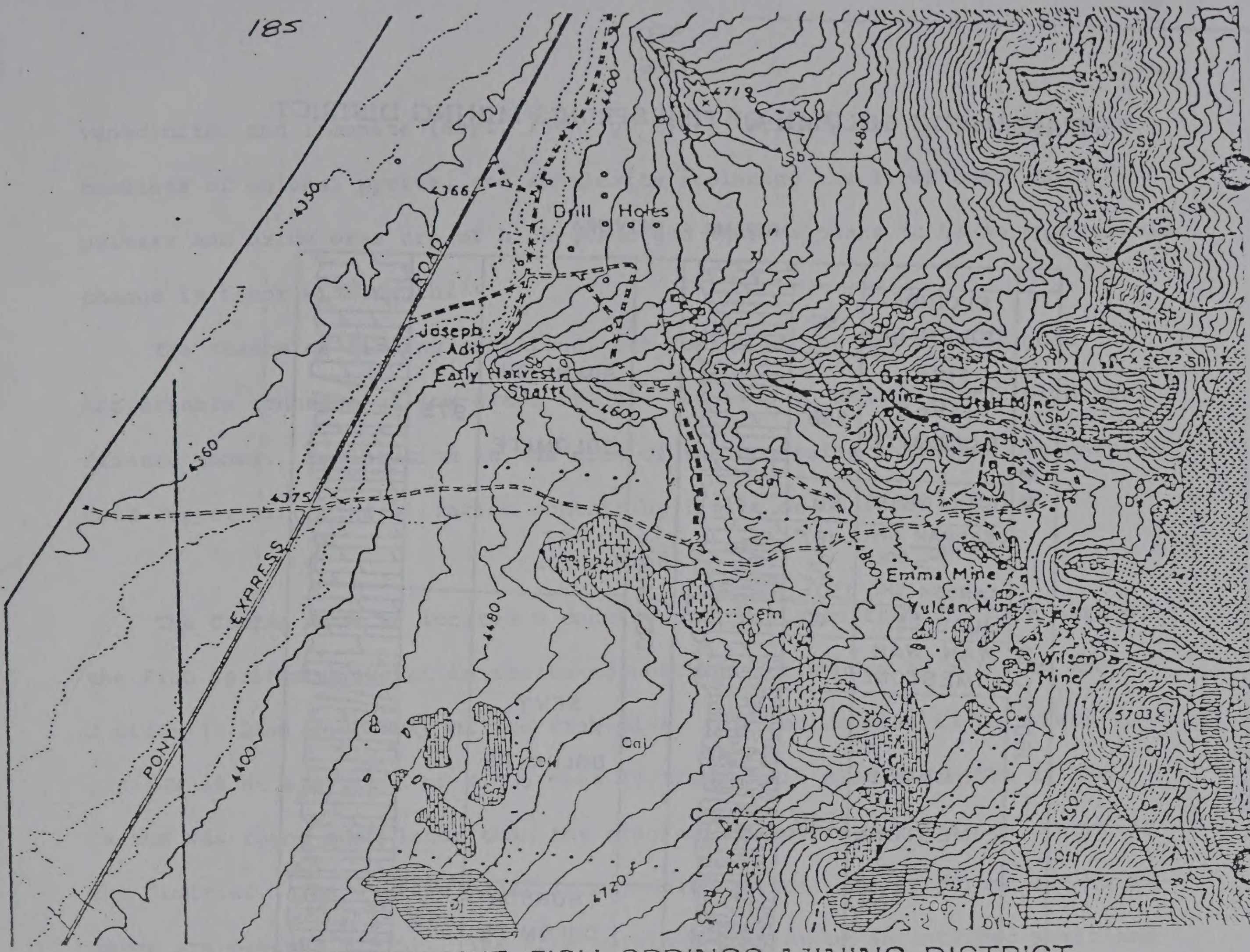


Figure 74: GEOLOGY OF THE FISH SPRINGS MINING DISTRICT

by Michael E. Oliveira

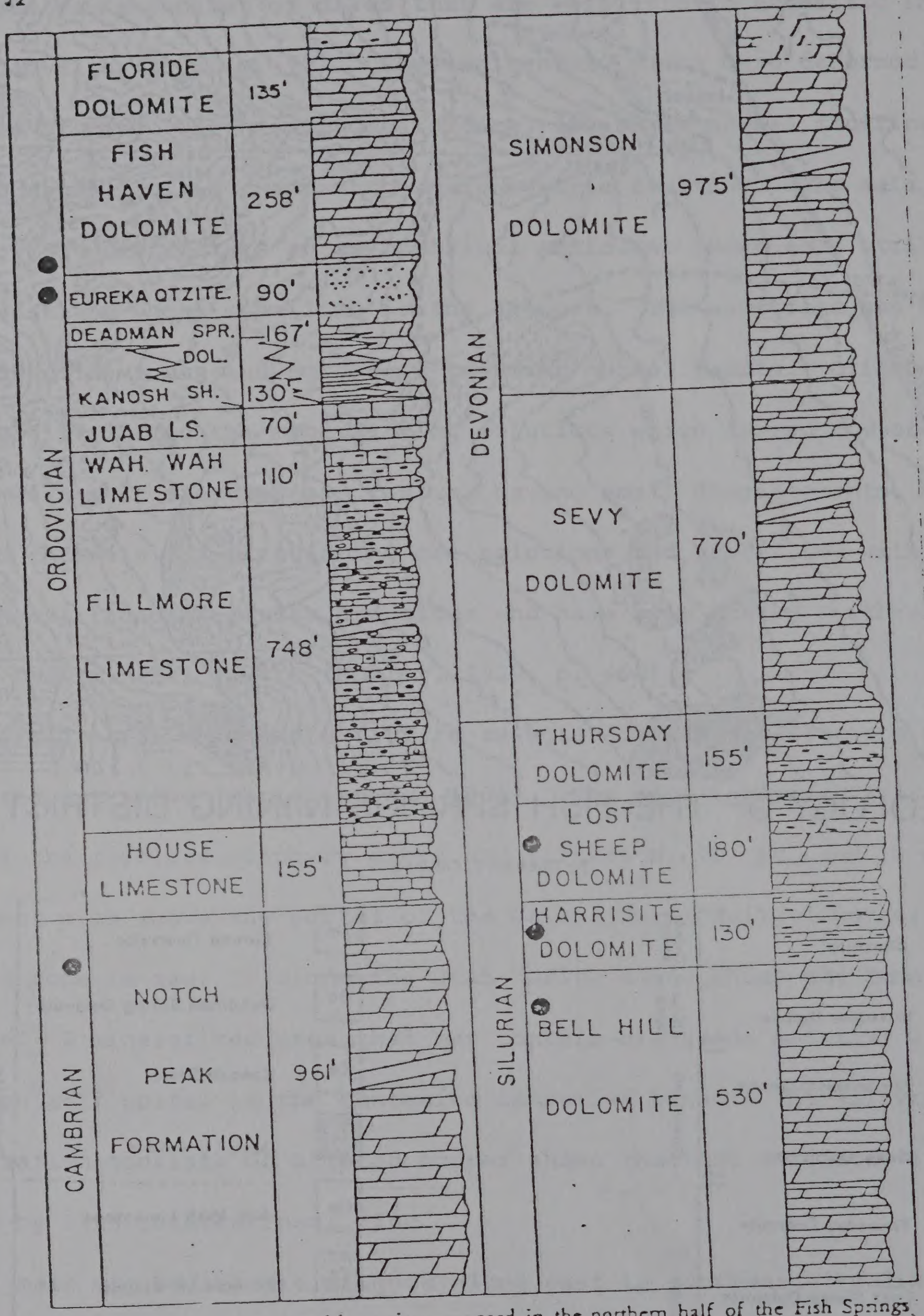
Symbol	Unit	Age
Qal	Alluvium	Quaternary
▬	Intrusive Bodies	Oligocene
Dsi	Simonson Dolomite	Devonian
Ds	Sevy Dolomite	
St	Thursday Dolomite	Silurian
Sl	Lost Sheep Dolomite	
Sh	Harrisite Dolomite	
Sb	Bell Hill Dolomite	
Ofl	Floride Dolomite	Ordovician
Ofh	Fish Haven Dolomite	

Symbol	Unit	Age
Oe	Eureka Quartzite	Ordovician
Od	Deadman Spring Dolomite	
Ok	Kanosh Shale	
Oj	Juab Limestone	
Ow	Wah Wah Limestone	
Of	Fillmore Limestone	
Oh	House Limestone	
Cn	Notch Peak Formation	Cambrian
30	strike and dip of beds	
—•----	Fault, dashed where inferred, dotted where concealed, ball on downthrown side	

adapted from Oliveira, 1975

STRAIGRAPHIC COLUMN OF FISH SPRINGS MINING DISTRICT

72 MICHAEL E. OLIVEIRA



– Stratigraphic sections exposed in the northern half of the Fish Springs Range.

from Oliveira, 1975

● Ore-bearing horizons

Figure 75: Stratigraphic column of rocks exposed in the north half of the Fish Springs Range

vanadinite, and limonite (Heyl, 1963, p. B79). Primary ore in the Utah mine consists of galena, pyrite, and sphalerite replacing the limestone. Both primary and oxide ores are of high-grade and there appears to be no appreciable change in tenor with depth.

The chance of finding additional ore bodies in the district is good. Appreciable tonnages of low-grade ore are reported to remain in the principal fissure zones. Exploration in the area of the concealed intrusive may uncover good copper-zinc mineralization containing little or no lead.

Cactus Mine

The Cactus mine is located a considerable distance from the main part of the Fish Springs district in scattered outcrops surrounded by alluvium about 2 miles (3.2km) southwest of the Utah mine. The Cactus mine is in SWSWNW 30-11S-14W at an elevation of 4,635 feet (1,413m). The mineralization at the Cactus was found much later than the original discoveries in the main part of the district. The surface plant is partially intact, the headframe and hoist-house are present (1976). The mine workings consist of an inclined shaft and two levels with a combined length of workings amounting to 400 feet (122m).

The shaft collar is in the Fish Haven Dolomite, but 20 feet (6m) below the shaft cuts the Eureka Quartzite. The original discovered ore cropped out in the Fish Haven Dolomite, but most of the workings are in the Eureka Quartzite. The quartzite is highly fractured in the mine workings and minerals fill the fractures. The ore bodies are replacements in the Fish Haven Dolomite and fracture fillings in the underlying Eureka Quartzite. The inclined shaft is sunk on a fault striking N. 3° E. and dipping 53 degrees to the east. The fault is mineralized with much limonite, clay, and secondary lead and zinc minerals, such as cerussite, anglesite, plumbojarosite, along with hematite. The ore bodies are narrow and rarely exceed 1 foot (0.3m) in width . A sample of ore, from a stope on the 50-foot level northwest of the shaft, assayed 19.9 percent lead, 0.2 percent zinc, and 1.5 ounces of silver per ton. The sample was channeled across a mineralized fracture 4 inches (10cm) wide. Little ore remains in the workings, but exploration might develop more ore, especially in the carbonate rocks which underlie the Eureka Quartzite.

Early Harvest Mine

The Early Harvest mine is located on top of Joseph Spur in the western part of the district and can be reached only on foot. The Early Harvest No. 1 shaft is in SENWSE 18-11S-14W at an elevation of 4,590 feet (1,399m). The mine was developed as a result of discovering and exploring small fracture fillings of secondary lead and zinc minerals. The mine workings consist of five shafts. The main No. 1 shaft is approximately 200 feet (61m) deep, from the bottom of which a drift has been driven northwesterly and a winze sunk 30 feet (9m) to explore small stringers of oxide ore. This drift was broken into during the driving of the Joseph adit in an attempt to cut the western end of the Utah-Galena fissure zone. The other four shafts are shallow and have no workings of consequence associated with them. Total workings on the property amount to about 800 feet (244m). The mine has not been worked for several years.

The Early Harvest mine is in the Notch Peak Formation and its workings are roughly aligned along the district's anticline (Joseph anticline). Northwest fractures have been filled by lead-zinc-silver mineralization. The ore body is small and consists of stringers along the northwest fractures. The 200-foot level of the main shaft follows the fractures for 200 feet (61m). The winze is located 131 feet(40m) from the shaft station. The fractures are generally 1/2 to 1 inch (12-25mm) in width, occasionally thickening to 6 inches (15cm). Minerals observed are cerussite, anglesite, and limonite. There are no demonstrable reserves in the mine.

Emma Mine

The Emma mine is 1,500 feet (457m) southeast of the Utah mine in NWNWNE 20-11S-14W at an elevation of 4,950 feet (1,509m) above sea level. The Emma mineralization was discovered shortly after that of the Utah and Galena mines. Heyl (1963, p. B78) reports the mine to be the third largest producer in the district, but production figures are unavailable. There has been no recent production, the dumps suggest several hundred feet of underground workings.

The Emma mine is in the Cambrian Notch Peak Formation and is associated with a rhyolite dike that strikes northwesterly. Underground workings are along a fissure zone striking N. 60° W. and dipping 55 degrees to the northeast. The orebodies occur as replacements along the fissure (figure 76). The concealed Juab fault, which lies beneath the alluvium south of the mine, may have been a channelway for the passage of ore-bearing solutions. Ore mined has been secondary, containing residual primary minerals. Minerals in the Emma ore are galena, sphalerite, plumbojarosite, anglesite, cerussite, cerargyrite, covellite, hemimorphite, smithsonite, aurichalcite, wulfenite, hydrozincite, willemite, and limonite (Bullock, 1967, p. 35). Heyl (1963, pl. 8) suggests that the ore bodies are not mined out at depth and projects reserves below the workings of the mine. The amount would be small, but the grade high.

Galena Mine

The Galena, the second largest mine of the district, is 800 feet (244m) west of the Utah mine. It is in NWSESW 17-11S-14W at an elevation of 5,100 feet (1,554m) above sea level. Mineralization was discovered in 1890 at the same time as that of the Utah mine. It has been credited with producing 3,000 short tons of ore having a gross value of $330,000, of which $80,000 were paid in dividends (Butler, 1920, p. 466). The mine shipped the first ore in 1891 and continued to produce irregularly for several years. Presently the mine appears to have been inactive for many years. Mine workings consist of a main shaft 700 feet (213m) deep and several shallow shafts and prospects. Workings are along the same fissure zone mined by the Utah mine and underground may connect in several places. The dump of the main shaft suggests several thousand feet of underground workings.

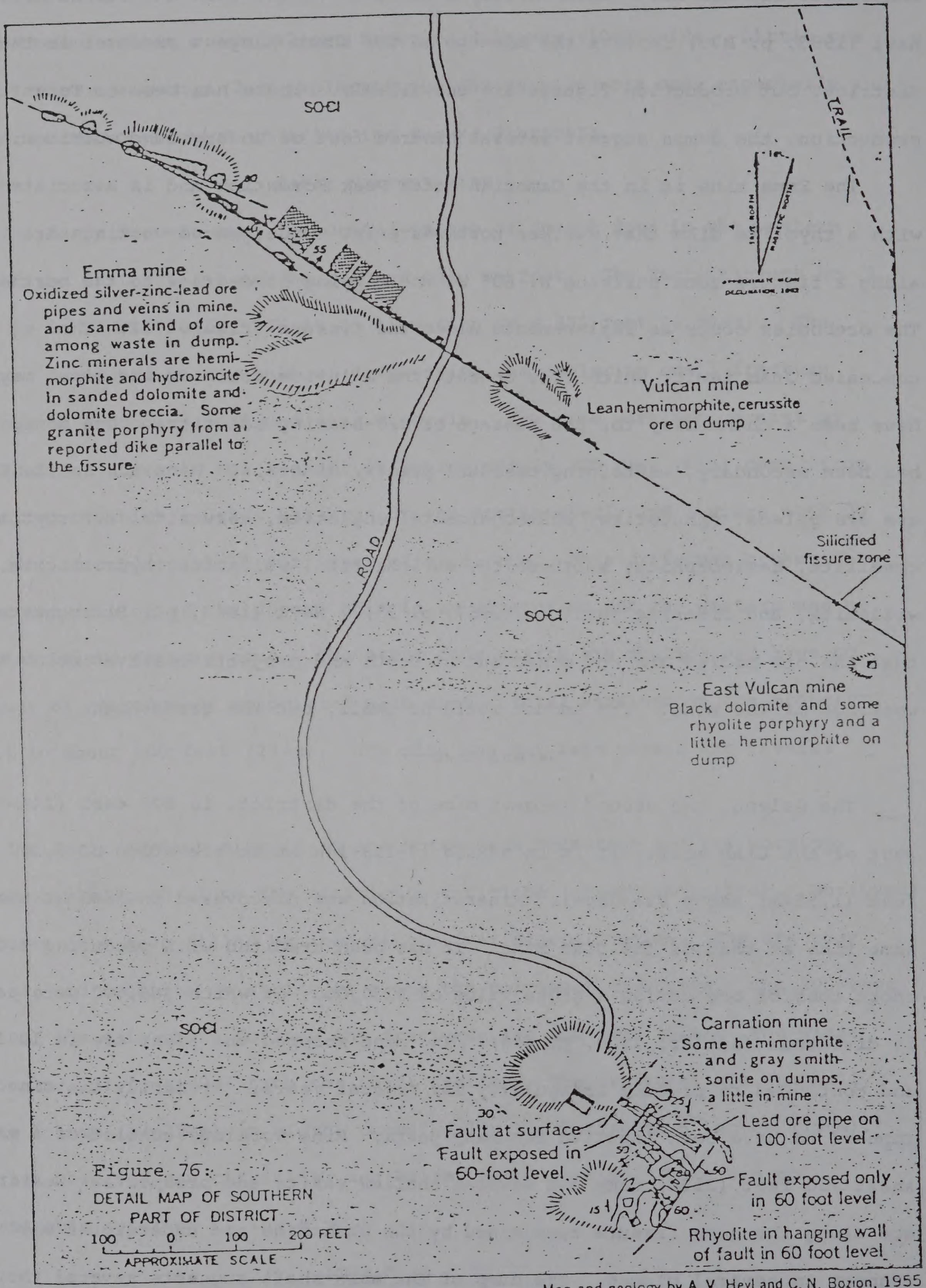

SO-Cl
TRAIL
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1963
Emma mine
Oxidized silver-zinc-lead ore pipes and veins in mine, and same kind of ore among waste in dump. Zinc minerals are hemimorphite and hydrozincite in sanded dolomite and dolomite breccia. Some granite porphyry from a reported dike parallel to the fissure
55
Vulcan mine
Lean hemimorphite, cerussite ore on dump
ROAD
Silicified fissure zone
SO-Cl
East Vulcan mine
Black dolomite and some rhyolite porphyry and a little hemimorphite on dump
SO-Cl
Carnation mine
Some hemimorphite and gray smithsonite on dumps, a little in mine
30
25
Fault at surface
Fault exposed in 60-foot level
Lead ore pipe on 100-foot level
50
50
Fault exposed only in 60 foot level
15
60
Rhyolite in hanging wall of fault in 60 foot level
100
0
100
200 FEET
APPROXIMATE SCALE

Figure 76:
DETAIL MAP OF SOUTHERN PART OF DISTRICT

Map and geology by A. V. Heyl and C. N. Bozion, 1955

from Heyl, 1963

The main shaft is collared in the Silurian Lost Sheep Dolomite near its contact with a rhyolite dike. The lower workings of the mine probably penetrate the Harrisite and Blue Bell Dolomites. The shaft is near the axis of the Utah syncline which trends northwesterly. The carbonate rocks have been cut by the east-trending Utah-Galena fissure zone along which the orebodies are found. These are on the south side of the rhyolite dike in the Utah-Galena fissure zone. The ore-bearing solutions migrated up and along the fissures until favorable beds for replacement were encountered. The east-trending orebodies are narrow and dip steeply to the south. The ore in the upper levels of the mine was almost completely oxidized, primary ore was encountered at lower levels. The unoxidized ore consists of argentiferous galena, sphalerite, chalcopyrite, and pyrite. Oxidized ore contains cerussite, anglesite, ruby silver, hemimorphite, smithsonite, plumbojarosite, hydrozincite, aurichalcite, covellite, willemite(?), wulfenite, vanadinite and limonite. There are no remaining high-grade reserves in the mine, but appreciable tonnages of low-grade are reported in the main fissure zones (Heyl, 1963, p. B80). Exploration below the water table in the area of the mine may develop additional ore of the grade that has been mined in the past.

Joseph Adit

The Joseph adit is the westernmost mine in the principal part of the district. It is on the western end of Joseph Spur and accessible from the Pony Express road. The portal of the adit is in SWNWSE 18-11S-14W at an elevation of 4,420 feet (1,347m). The Joseph adit was one of the last developed in the district and was driven with the intention of cutting the west end of the Utah-Galena fissure. The adit was abandoned before reaching its destination. Workings consist of approximately 1,300 feet (396m) of drifts. The adit is cut in the Notch Peak Formation and remains in it throughout its length. Drifting connects with the Early Harvest No. 1 workings, where mineralized fractures containing cerussite, anglesite, and limonite were followed. Otherwise there is no mineralization in the Joseph adit and no reserves.

Utah Mine

The Utah mine is in NESENW 17-11S-14W at an elevation of 5,130 feet (1,564m). Mineralization was discovered in 1890 when C. C. Van Alstine found mineralized float on the property. To 1914 the mine is credited with producing 12,997 short tons of ore from which were recovered, 11,447,930 pounds of lead, 1,668,205 ounces of silver, and $6,227 in gold. The ore, when it was produced, had a value of $1,580,186 and had an average grade of 44.04 percent lead, 128.35 ounces silver to the ton, and $0.48 gold per ton. Since 1914 the mine was worked intermittently and the last operation occurred in the early 1960s. The last work consisted of handpicking dumps and limited underground work. The Utah shaft is at least 800 feet deep (244m), and the rock on the mine dump indicates several thousand feet of underground workings. These are extended along an east-southeast trend and consist of stopes and drifts. The upper levels of the mine are dry to the 800-foot level where the water table is encountered.

The shaft is collared in the Silurian Lost Sheep Dolomite and workings probably extend down to the Blue Hill Dolomite. The orebodies in the Utah mine are related to the Utah-Galena fissure zone which trends easterly and lies to the south of the largest rhyolite dike in the district. The orebodies occur very irregularly along the fissures where they come in contact with favorable dolomite beds. It has been the practice to follow these fissures even though they become very tight, several small orebodies have been found in this manner. Little ore has been found at the rhyolite dike contact, but most has been found less than 100 feet from it in the dolomite. Prospecting has been conducted to the north of the dike without success. Alteration of the host rock is minor and does not help in locating ore. The ore occurs as replacements of favorable carbonate rocks. Primary ore consists of galena, containing considerable silver, sphalerite, and calcopyrite accompanied by pyrite. Secondary ore consists of cerussite, anglesite, plumbojarosite, ruby silver, calamine, smithsonite, hydrozincite, aurichalcite, willemite(?), wulfenite, vanadinite, and limonite. Both the primary and secondary ores are high in silver. High grade sulfide ore remains below the water table, but the amount is unknown. Appreciable tonnages of low-grade ore remain in the main fissure zones. The mine area has a good chance of containing additional economic ore, however, it is expected that the bodies will be small and costly to mine.

Vulcan Mine

The Vulcan mine is in SWNWNE 20-11S-14W at an elevation of 5,015 feet (1,529m) above sea level and 2,400 feet (732m) southeast of the Utah mine. The mineral discovery was made at about the same as that at the Emma property and lies adjacent to the same fissure zone. No production figures are available, in the summer of 1976 the mine had been idle for several years. Workings consist of four shafts, 1 major and 3 minor, which contain approximately 1,000 feet (305m) of drifts and stopes.

The shaft collar of the major shaft is in alluvium, the lower workings reach the Cambrian Notch Peak Formation. The mine is located south of the Emma and the concealed Juab fault lies north of the shaft collar. The fault may have acted as a channelway for the mineralizing solutions. Ore is replacement in the Notch Peak Formation. The ore strikes N. 60° W. and dips steeply to the northeast and contains galena, sphalerite, plumbojarosite, anglesite, cerussite, serargyrite, coyellite, hemimorphite, smithsonite, aurichalcite, wulfenite, hydrozincite, and willemite. There are no known reserves in the East Vulcan mine, future exploration may find additional ore down dip on the fissure or paralleling fissures.

Wilson (Carnation) Mine

The Wilson or Carnation mine is 1,200 feet (366m) southeast of the Emma mine in NWSENE 20-11S-14W at an elevation of 5,490 feet (1,673m). The mine mineralization was discovered before 1920, total production is believed to be small. The mine consists of two levels, at 60 and 100 feet, the total workings have a length of about 800 feet (244m).

The workings are cut in the Cambrian Notch Peak Formation. The dolomite has been cut by a northeast-trending fault that dips 50 degrees to the southeast and which has been the controlling feature for ore deposition. Mineralization occurs as a replacement of dolomite as pipes and shoots adjacent to the fault. Oxidation has altered the primary ore and only secondary minerals remain. Minerals in the Wilson mine are cerussite, anglesite, plumbojarosite, cerargyrite, hemimorphite, smithsonite, and limonite. No exploration has been conducted below the 100 level and additional ore might be developed at depth.

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Tintic District

The Tintic mining district has been one of the leading areas of metal output in the state and is surpassed only by West Mountain (Bingham) and Park City. The district is located approximately 75 miles southwest of Salt Lake City in the East Tintic Mountains and is partly in Juab and partly in Utah County. Through 1976 almost 13.5 million tons of ore have been mined, yielding base and precious metals valued in excess of 320 million dollars. The first ore discovery in the East Tintic Mountains was in 1869 on a mineralized fissure in the Silver City stock. Limestone replacement ores were soon found near what were to become the Mammoth and Eureka Hill mines. Considerable development work occurred between 1880 and 1910 and ore was extracted from the south and central portions of the Gemini and Chief ore zones (Cook, 1957, p. 57). John Beck was the first to successfully locate a concealed ore body when he sank an exploratory shaft in the bottom of Eureka Gulch and discovered large and rich orebodies on the northern continuation of the Gemini ore zone. In 1905 two new ore zones, the Iron Blossom and Godiva, were discovered by Jesse Knight. Another important discovery of concealed ore was made in 1910 by Walter Fitch and J. R. Finlay. A shaft was sunk in Eureka Gulch through the rhyolite and at 1,400 feet (247m) below the surface large ore bodies on the northern extension of the Chief ore zone were discovered. The last important ore zone or run to be discovered was the Plutus in 1910 although numerous and extensive exploration efforts have been made. In 1976 only the Mammoth mine was producing lead and zinc minerals. Production of ore and metals from the main Tintic mining district is presented in table 20.

The East Tintic Mountains are typical of the north-trending mountain ranges of the Basin and Range Physiographic Province, whose origin is attributed to block faulting. They are bordered on the west by Tintic and Rush Valleys, on the east by Dog, Goshen, and Cedar Valleys. The maximum relief of the range is 3,800 feet (1,158m). Boulder Peak is the highest prominence in the range at 8,306 feet (2,532m) but is west of the main divide on a high spur. Consolidated sedimentary rocks, exceeding 32,000 feet (9,754m) in thickness exposed in the East Tintic Mountains are strongly folded and complexly faulted and range from Late Precambrian to Permian in age (figures 77 and 78). The internal structure of the range records a complex structural development antidating the block faulting. The northern third is dominated by north-trending anticlines and synclines superimposed on the north flank of a broad east-trending uplift extending through the range at the latitude of Tintic Mountain. Much of the

Table 20: *Production of Ore and Metals from Main Tintic Mining District, 1869–1965, by 10-year Periods*[1]

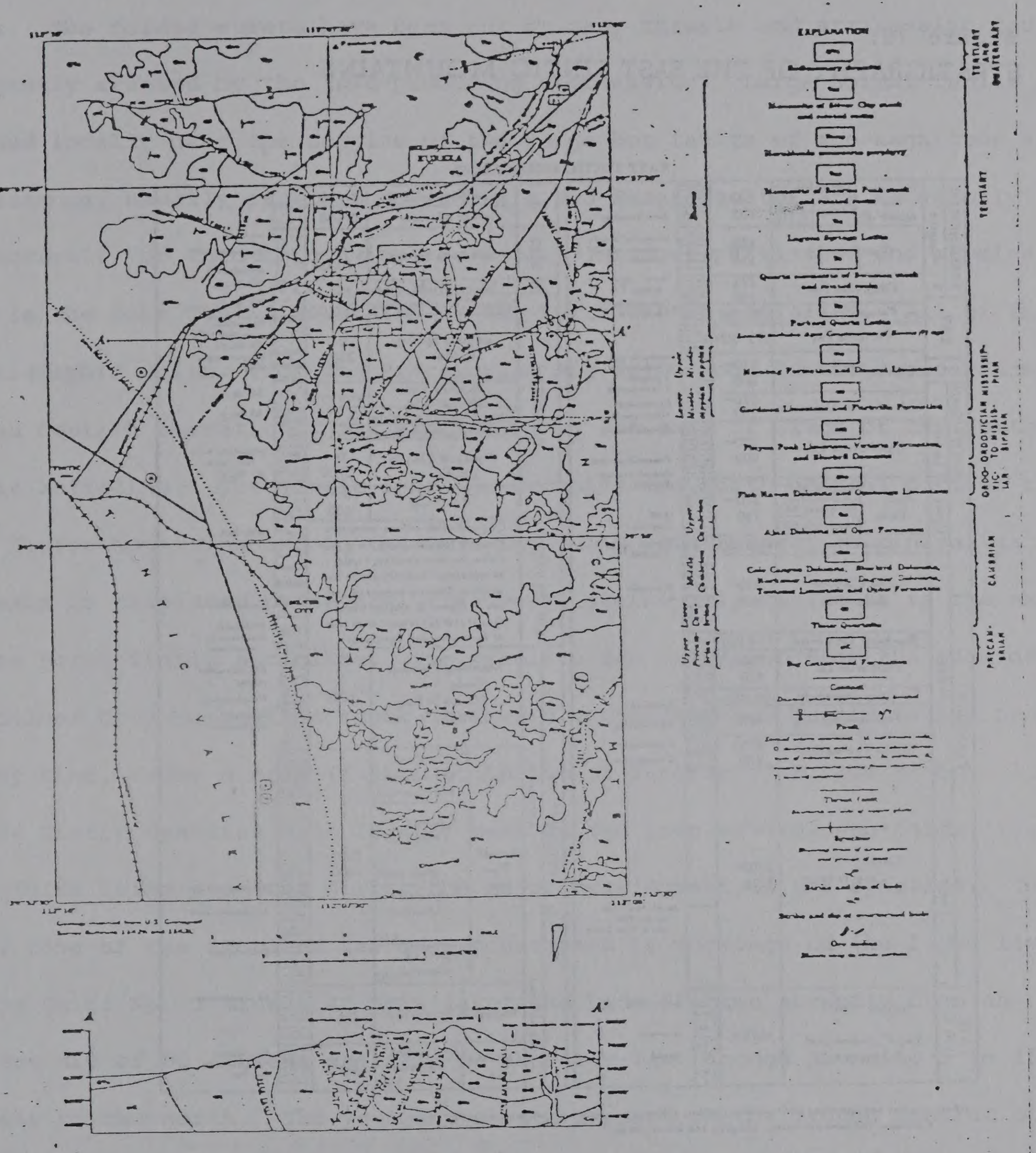
Period	Ore (short tons)	Gold (fine ounces)	Silver (fine ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1869–1880	3,666,671	36,149	1,605,545	3,179,628	10,353,378	—
1881–1890		61,786	11,692,031	9,692,031	54,318,428	—
1891–1900		332,518	31,366,185	21,441,370	187,524,539	—
1901–1910		731,312	31,856,168	76,565,474	279,893,533	—
1911–1920	3,358,073	496,927	54,227,364	71,086,437	289,143,135	16,914,973
1921–1930	2,674,335	218,712	45,621,103	23,994,912	300,264,767	12,927,818
1931–1940	1,099,913	187,375	8,176,028	8,535,664	20,261,646	2,774,092
1941–1950	1,761,943	64,177	8,689,849	4,838,969	86,444,873	67,339,058
1951–1960	825,605	21,019	4,131,117	1,415,653	58,398,642	38,046,531
1961–1965	50,599	408	31,794	44,300	101,600	42,531
Totals	13,437,139	2,150,383	197,397,184	220,794,438	1,286,704,541	138,045,003

[1] Statistics derived by subtracting the production from mines in East Tintic district from data presented in the following reports: (1) U.S. Geol. Prof. Paper 107; (2) U.S. Geol. Survey Mineral Resources of the United States 1917–1923; (3) U.S. Bureau of Mines Mineral Resources of the United States 1924–1931 and U.S. Bureau of Mines Minerals Yearbook, 1932–1965; (4) Utah Geological and Mineralogical Survey Guidebook to the Geology of Utah, No. 12; and (5) private sources.

Note: Examine differences between these figures and those on table 18. Production figures for Juab County must be larger than those for the Tintic district alone. Incomplete production records may account for some of this error.

Figure 77:

GEOLOGIC MAP OF THE TINTIC MINING DISTRICT



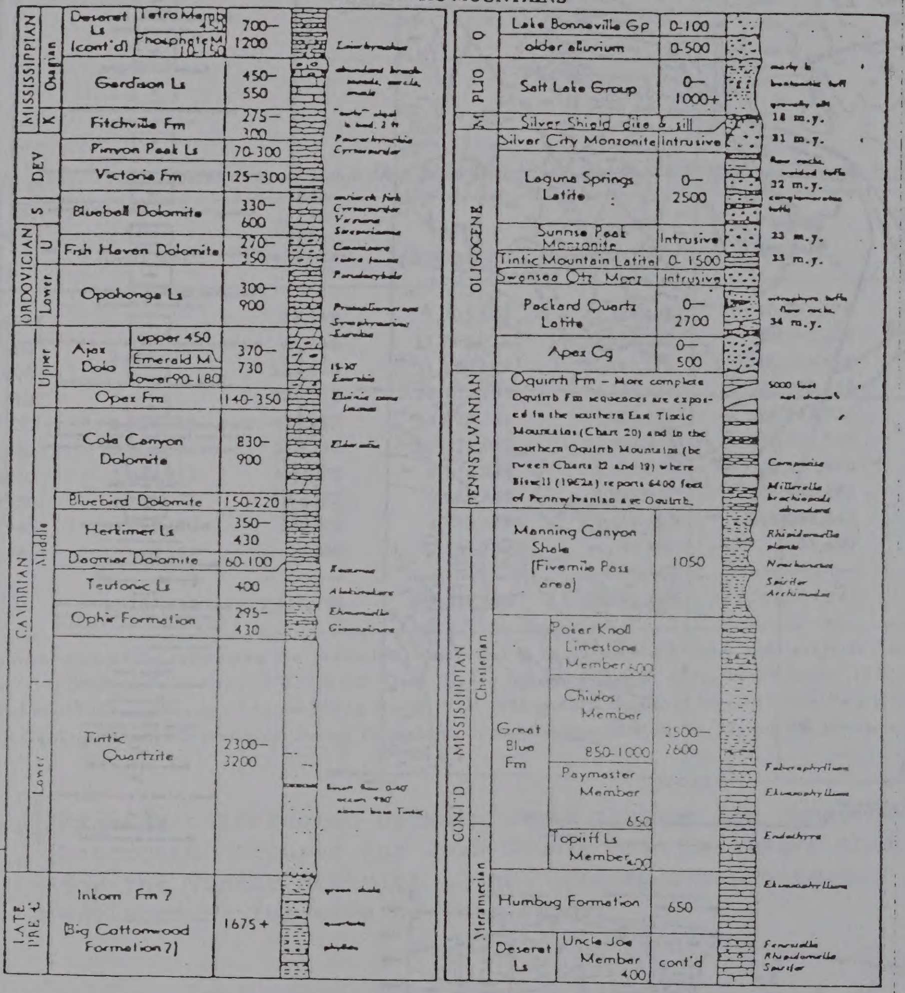
Generalized Geologic Map and Section of Main Tintic Mining District.

Adapted from Morris, 1968, p.1048

Figure 78:

STRATIGRAPHY OF THE EAST TINTIC MOUNTAINS

EAST TINTIC MOUNTAINS



After: Morris and Lovering (1961); Morris (1964a), (1964b); Precambrian: Woodward (1972)
Cenozoic radiometric dates: Laughlin and others (1969)

Adapted from Geologic History of Utah by L.F. Hintze, p. 136

geologic structure involving the Paleozoic sediments of the south-central and eastern part of the range is concealed beneath an extensive lava field. The scattered exposures indicate strata generally dip to the south and are very thick. The folded strata have been cut by many thrusts and strike-slip faults apparently created by the fold-producing compression. Large normal faults are exposed locally near the margins of the range but faults of the magnitude and persistence, usually referred to as Basin and Range faults, are known only conjecturally or through gravimetric data. The most persistent and prominent fold in the East Tintic Mountains is the North Tintic anticline. All of the stratigraphic units, from the Precambrian Big Cottonwood to the Permo-Pennsylvanian Oquirrh Formations, are exposed along the axis or limbs of the North Tintic anticline. The Tintic syncline occupies the north-central part of the East Tintic Mountains and is the more important with respect to mineralization. The axis is displaced by several transverse strike-slip faults as is the axis of the North Tintic anticline. The syncline can be traced from the edge of the Silver City monzonitic stock northward to the Packard Quartz Latite near the Mayday mine, about a mile (1.6km) southeast of Eureka. The beds of both limbs of the Tintic syncline have locally been folded into several sub-folds, these drag-folds being produced during the major development of the syncline. The axial zone of the syncline has been penetrated by workings on the 1,800 level of the Chief No. 1 mine. At this level the beds flatten abruptly from an average dip of 80 degrees easterly to a nearly flat trough plunging 5 to 15 degrees to the north. The youngest strata exposed in the trough consist of the lower beds of the Mississippian Great Blue Limestone and the oldest rocks exposed on the limbs consist of the lowermost beds of the Cambrian Tintic Quartzite. The Tintic Quartzite crops out on a west-projecting ridge on the west side of the range.

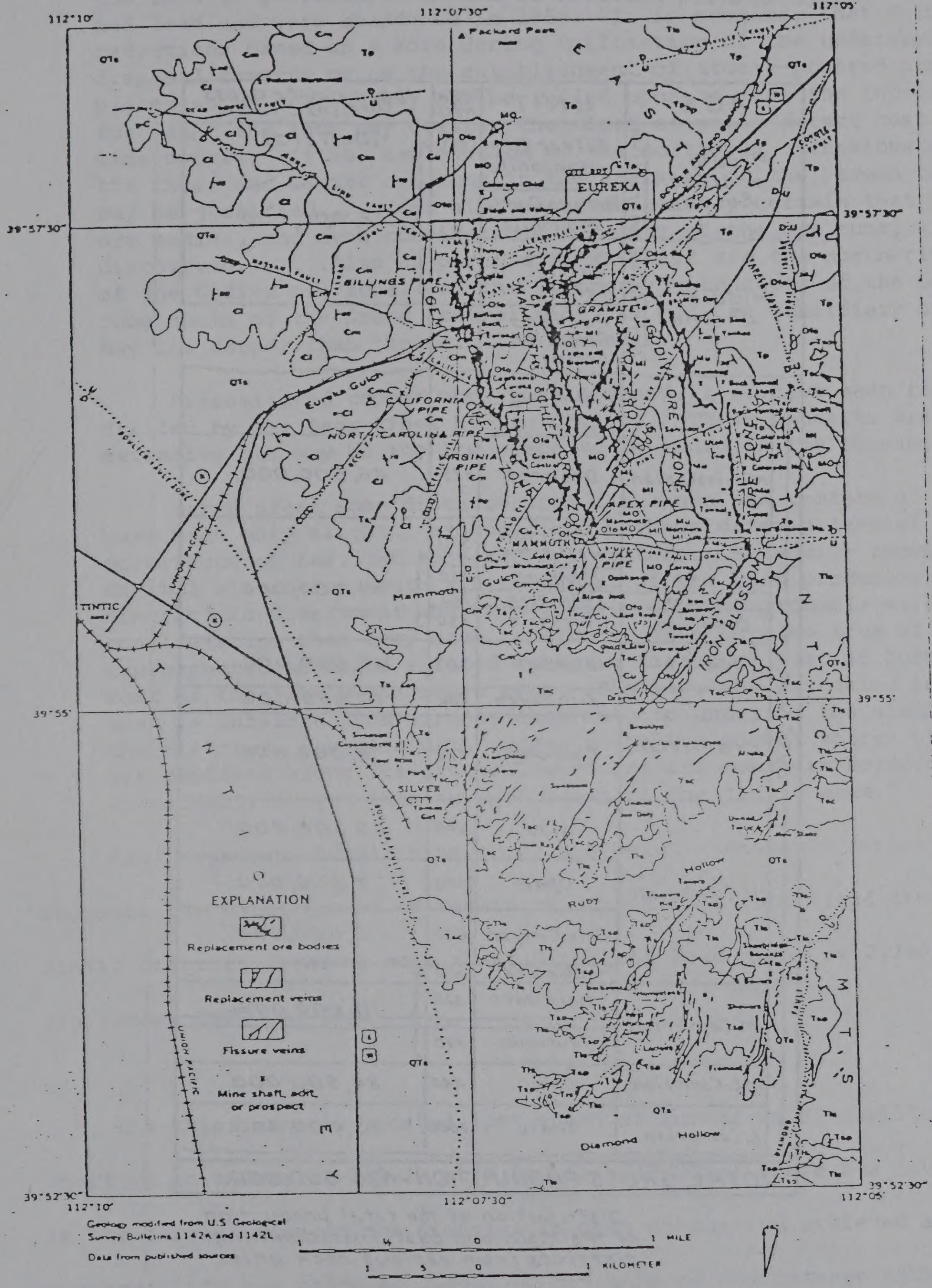
The ores in the district have been mined from several horizons and rock types. The value of each with respect to metal production has been calculated by Cook (figure 79). Ore zones or runs of the district have been discussed by Morris (1968):

> "The metalliferous ore deposits of the Tintic district include both fissure and replacement veins as well as the extensive replacement ore bodies for which the district is so widely known. Together, these ore deposits form persistent linear zones (or ore runs) that extend north-northeasterly across the Silver City stock and adjacent rocks and northerly through the sedimentary rocks north of the Sioux-Ajax fault... ...In the carbonate rocks north of the stock, five zones of replacement ore bodies are recognized... ...beginning with the westernmost: (1) the Gemini..., (2) the Mammoth-Chief..., (3) the Plutus..., (4) the Godiva..., (5) and the Iron Blossom.... ...Two of these zones, the Gemini and Plutus ore runs, do not extend southward as far as the Sioux-Ajax fault but merge with the Mammoth Chief zone near the Grand Central mine.
>
> The linear character of the three principal ore zones persists through the Silver City stock and beyond it into the altered lavas and tuffs bordering Diamond Hollow...
>
> ...More than 90 percent of the ore produced from the Tintic district has come from ore bodies that have replaced folded and faulted carbonate rocks of Paleozoic age. These replacement ore bodies range in size from insignificant stringers and small kernels to great columnar, linear, and bulbous masses, some containing several hundred thousand tons of ore...
>
> ...The most productive of the replacement ore bodies are the great columnar masses or chimneys, locally termed pipes, that were mined in the Mammoth, Chief, Gemini, Centennial Eureka, Gold Chain, and other mines...
>
> ...South of the Sioux-Ajax fault,in the pyrometasomatized carbonate rocks near the Silver City stock, the ore bodies are less irregular in form than those north of the fault and assume the aspect of typical replacement veins. Essentially all of them are narrow relative to their length and height, but, unlike the fissure veins in the adjacent intrusive rocks, they more completely replace the breccia fillings of the fissure zones and locally expand on cross fractures and bedding breccias...
>
> ...Many of the ore bodies in the Tintic Quartzite, Opohonga Limestone, and the volcanic rocks... ...commonly show little evidence of wall rock replacement and locally are classified as fissure veins. These veins have quite smooth, well-defined contacts with the altered country rock and, unlike the replacement veins range in width from knife-seams to about 20 feet, averaging about 2 feet. Most are less than a few hundred feet long, although the Sunbeam vein is nearly continuous for about 4,000 feet. The structures occupied by the veins seem to be small normal faults with an average strike of N. 20° E., the average dip is 75 to 85 degrees west, but some veins are vertical and others dip east."

Figure 80 shows the distribution of the ore runs and bodies of the district projected vertically to the surface. Future mining in the Tintic district will depend largely on new discoveries through continued exploration efforts. The potential for the district is summarized by Morris (1968, p. 1072-1073) as follows:

LOCATION MAP OF MINES AND ORE BODIES OF THE TINTIC DISTRICT

Figure 80:



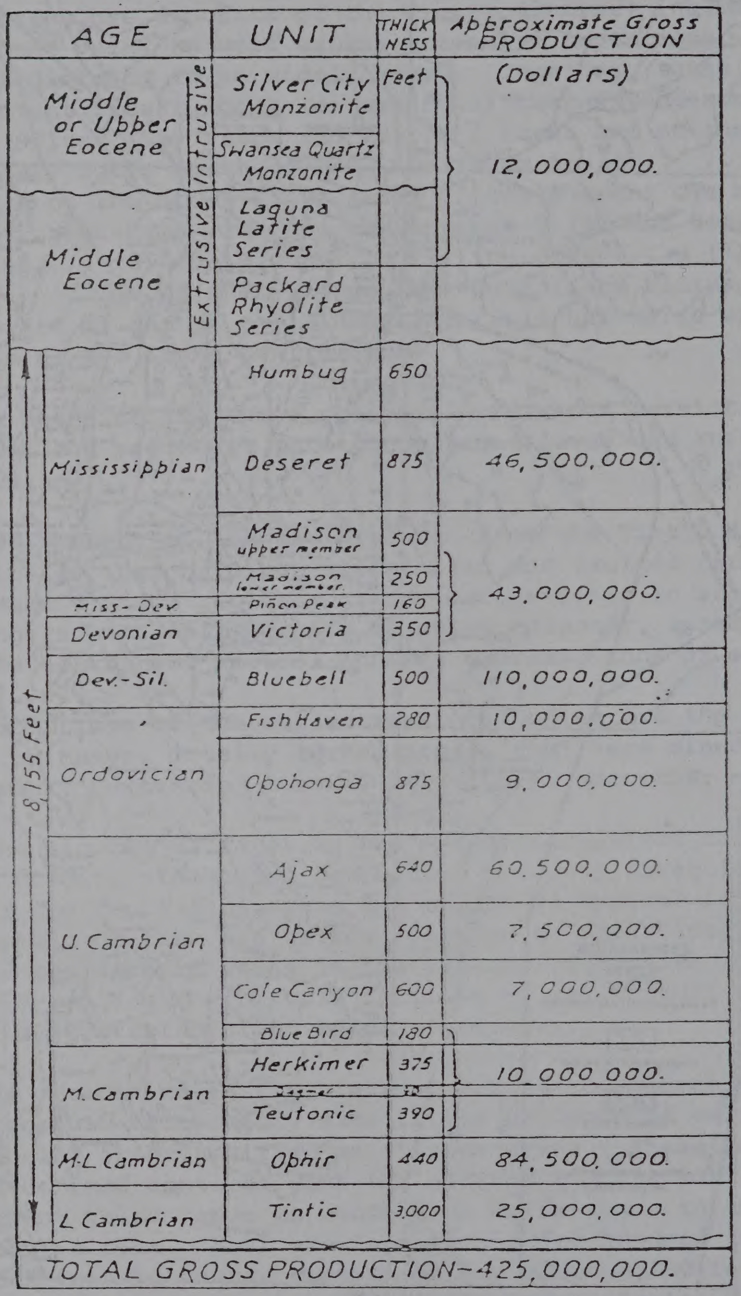
Geology modified from U.S. Geological Survey Bulletins 1142A and 1142L

Data from published sources

Vertical Projection of Ore Bodies, Main Tintic Mining District.

Adapted from Morris, 1968, p. 1054

Figure 79:
Ore-bearing horizons of the Tintic district



	AGE		UNIT	THICKNESS	Approximate Gross PRODUCTION
	Middle or Upper Eocene	Intrusive	Silver City Monzonite	Feet	(Dollars) 12,000,000.
			Swansea Quartz Monzonite		
	Middle Eocene	Extrusive	Laguna Latite Series		
			Packard Rhyolite Series		
8,155 Feet			Humbug	650	
	Mississippian		Deseret	875	46,500,000.
			Madison upper member	500	
			Madison lower member	250	43,000,000.
	Miss-Dev		Piñon Peak	160	
	Devonian		Victoria	350	
	Dev.-Sil.		Bluebell	500	110,000,000.
	Ordovician		Fish Haven	280	10,000,000.
			Opohonga	875	9,000,000.
	U. Cambrian		Ajax	640	60,500,000.
			Opex	500	7,500,000.
			Cole Canyon	600	7,000,000.
			Blue Bird	180	10,000,000.
	M. Cambrian		Herkimer	375	
			[illegible]	[illegible]	
			Teutonic	390	
	M-L Cambrian		Ophir	440	84,500,000.
	L Cambrian		Tintic	3,000	25,000,000.
	TOTAL GROSS PRODUCTION–425,000,000.				

Distribution of the total production of the Main and East Tintic mining districts from various rock units.

Adapted from Cook, 1957, p. 65
]

"The known ore bodies on the lowest levels of the Chief and Gemini mines could not by themselves, pay mounting mining and pumping costs in the face of gradually diminishing size and decreasing tenor of silver and lead and were abandoned in 1955. It is possible that future cost reductions based on a more daring utilization of the underground water-disposal caverns or on the establishment of atomic-powered pumping plants which conceivably may be called upon to meet the increasing demands for water and thus may dewater the mines at small direct cost to the mine owners. If so, exploration of the northerly extensions of both the Chief and Gemini ore runs in the vicinity of the Paxman fault zone may be justified... ...it also seems reasonably certain that individual ore bodies, and even considerable segments of the ore runs, will be discovered... ...Also of particular interest are the northerly extensions of the Godiva ore zone, and the southerly extensions of the Gemini ore zone south of the Grand Central mine, as well as subsidiary ore runs that may lie deeper than the main ore channels.

Disseminated copper ores near Diamond... ...have been recently drilled by the Bear Creek Mining Company. These deposits are apparently extensive but may be too low grade to be mined in the foreseeable future.

Large areas some distance from the known ore centers of the district have been only slightly explored and perhaps offer potential for the occurrence of new, undiscovered ore centers. Extensive zones of hydrothermal alteration south and southeast of the main producing part of the district in Government and Copperopolis Canyons probably warrant more consideration than they have received. This is also true of the nearly unprospected areas of altered rocks in the upper part of Burriston Canyon east of the Iron Blossom ore zone. Finally, the concealed intrusive body that is inferred from aeromagnetic data to underlie the southern part of the district, may eventually prove to be the parent source of yet undiscovered ore deposits along its eastern, western, and southern borders that are conceivably larger than any yet known in the Tintic area."

Paul Mogensen, Burgin mine chief geologist (Kennecott Copper Corp.), suggests the total amount of remaining mineralized rock (lead-zinc ore) in the Tintic district, bearing more than 10 percent lead might be 2,250,000 tons (in James, 1973, p. 35).

Chief Mine

The Chief mine is located just south of Eureka in Fitchville; the No. 1 shaft is in SWSWNW 18-10S-2W at 6,580 feet (2,005m) above sea level. The Chief is the largest mine in the district in both production achieved and length of workings. It has produced 3,451,780 dry tons of ore between 1909 and 1956, yielding 200,496 ounces of gold, 52,098,123 ounces of silver, 410,540,082 pounds of lead, 10,878,115 pounds of copper, 165,711,842 pounds of zinc, which had a net smelter value of $48,770,940.34 (Evans, 1957, p. 93). The ore had an average grade of 0.1 ounce of gold, 15.5 ounces of silver, 0.3 percent copper, 6 percent lead and 2.3 percent zinc (Anonymous, 1957, plate 3). The Chief No.1 shaft was started in 1906 and first ore was encountered on the 1,400-foot level in 1910. Mining continued to the 1,800-foot level where the water-table was encountered. Pumps were installed in 1916 and sulfide ore was mined until 1927, the 2,500-foot level being reached. In 1927 depressed metal prices and high operating costs forced the abandonment of the pumping operation and the mine flooded to the 1,800-foot level. During the 1930s the mine was operated intermittently by lessees. In 1942 a government incentive plan made it feasible to dewater the mine and extract ore known to occur below the water table. By 1947 the mine workings had extended below the 2,700-foot level. In 1951 a new pumping system was installed and workings were deepened to the 3,050-foot level. In September 1954 economic conditions forced the abandonment of the deep levels but mining continued in upper levels until June 15, 1957 when the mine was finally shut down (Evans, 1957, p. 81 and 83).

The workings of the mine consist of two shafts, the No. 1 and 2, and four underground winzes connecting with the deepest 3,561-foot level in the mine. The No. 1 shaft, the main opening of the mine, is a 2 1/2 compartment shaft, 1,850 feet (564m) deep. Seven levels, at 200-foot intervals (21m), were turned from this shaft from a depth of 600 to 1800 feet (183- 549m). The No. 2 shaft, located 3,600 feet (1,097m) east of No. 1, is a 2-compartment shaft 1,800 feet (549m) deep and was used chiefly for ventilation. Approximately 120 miles (193km) of drifts, crosscuts, raises, and winzes are in the mine as well as several thousand feet of open stopes. The principal winze, 18-411, is located in the northeast part of the mine and extends from the 1,800 foot level to the 3,050-foot level. It consists of 2 1/2 compartments of which two were used for hoisting. Eleven levels were turned from the winze at 100-foot (15m) intervals from the 2,000 to the 3,000-foot level. The mine workings are mainly below the central and eastern part of Eureka townsite, although workings continue northeast and south from its boundaries. Minerals found in the Chief mine are galena, cerussite, anglesite, plumbojarosite, sphalerite, smithsonite, hemimorphite, wurtzite, argentite, cerargyrite, ruby silver, native silver, native gold, malachite, azurite, and conichalcite. Gangue minerals are pyrite, barite, jasperoid, quartz, limonite, hematite, and calcite. There are about 500,000 short tons of siliceous lead-silver ore left in the upper levels. The ore bodies were not exhausted when the lower levels were abandoned and allowed to flood, high pumping costs and a depressed metal market halted mining operations.

Eagle and Bluebell Mine

The Eagle and Bluebell mine is located approximately 2,800 feet (853m) southeast of Eureka and is 1,500 feet (457m) south of the Chief No. 1 shaft. The shaft collar is in NWNWNW 19-10S-3W at an elevation of 6,810 feet (2,076m). The mine is on the Chief ore run and lies between the Victoria mine on the south and the Chief mine on the north. Access to the mine is through a vertical shaft (No. 1) which has opened the mine to the water table 2,019 feet (615m) below the collar. Other openings on the property consist of an old tunnel and the No. 2 shaft, 1000 feet (305m) deep. The mine workings are extensive and probably exceed 5 miles (8km) in length. From 1897 to 1916 the mine produced 220,343 tons of ore yielding 35,385 ounces of gold, 3,217,676 ounces of silver, 1,413,102 pounds of copper, 33,796 pounds of lead and 22,856 pounds of zinc having a value of $4,450,905 (Lindgren and Loughlin, 1919, p. 208). To date the mine has produced 668,017 tons of ore averaging 0.1 ounce gold, 11.7 ounces silver, 0.2 percent copper, and 7.5 percent lead (Anonymous, 1957, pl. 3).

The mine workings are cut in the Bluebell Dolomite and Opohonga Limestone. The rocks generally strike N. 15° W. and dip 65-70 degrees to the east. Cross-fractures trend easterly, east-northeast, and west-northwest and are associated with ore bodies that replace the Bluebell Dolomite. There are two ore areas in the mine, the first was reached through the old tunnel, the second from the No. 2

shaft on the south side of the property. The two areas are separated by 800 feet (244m) of barren rock. The mine has produced widely differing ore-types, but all carry lead, gold, and silver. Minerals found in the mine are anglesite, bismite, bismutite, bismoclite, cerargyrite, cerussite, daubreeite, enargite, galena, jarosite, jasper, and smithsonite (Bullock, 1967, p. 38). There are no known reserves in the mine, which was worked to the water table. Explorational targets may exist below the now abandoned workings.

Victoria Mine

The Victoria mine is 3,900 feet (1189m) southeast of Eureka and 1,000 feet (305m) southeast of the Eagle and Bluebell No. 1 shaft. The shaft collar is in SESENW 19-10S-2W at 6,985 feet (2,129m) above sea level. The Victoria was owned and operated by the Victoria Mining Co. until 1915 when it was sold to the Eagle and Bluebell Mining Co. Access to the mine is through the shaft, which has a depth of at least 1,200 feet (366m) and from which several levels have been run. The 1,050 and 1,200 levels connect with workings of the Eagle and Bluebell mine. The Victoria is credited with producing 13,593 tons of ore having an average grade of 0.2 ounces gold, 9.6 ounces silver, 1 percent copper, and 2.6 percent lead (Anonymous, 1957, pl. 3).

The mine workings are cut in the Bluebell Dolomite which in the northern part of the property strikes N. 30-35° W. and dips 50-65° northeasterly. Replacement has taken place along the bedding and the ore bodies pitch to the north into the Eagle and Bluebell mine. The ores are generally highly siliceous gold-silver mineralizations with bunches of copper and rare lead. The lead ore consists of galena containing coarsely crystalline ankerite. Minerals in the mine are ankerite, barite, bismutite, calamine, cerussite, cerargyrite, enargite, galena, native gold, jasperoid, quartz, manganite, and limonite. There are no known reserves in the mine.

Gemini Mine

The Gemini mine is on the north side of Eureka Gulch and north of the

Bullion Beck mine. The Gemini shaft collar is in SESWNE 13-10S-3W at an elevation of 6,467 feet (1,971m). The mine was worked by a vertical shaft 1,650 feet (503m) deep from which levels have been turned every hundred feet (15m). An internal winze goes below the 1,600-foot level to the 1,900-foot level. The workings of the mine are extensive and probably total 20 miles (32.1km). The mine is credited with producing 298,052 tons of ore averaging an undetermined amount of gold, 31.1 ounces of silver, 0.3 percent copper, 10.5 percent lead, and 0.1 percent zinc (Anonymous, 1957, pl. 3).

The mine is cut in Ordovician and Mississippian carbonate rocks and mineralization has taken place along three principal zones or channels; Gem, Tank, and Red Bird. The Gem channel mineralization was encountered just above the 1,300 level and followed downward. It is unusual that secondary minerals are encountered below the water table and that the sulfide minerals are exceptionally rich in silver. The Tank and Red Bird channels are not as rich in silver and oxidation has not taken place below the water table. Minerals include anglesite, aurichalcite, azurite, calamine, cerargyrite, cerussite, galena, heulandite, hydrozincite, jasper, malachite, marcasite, pearceite, native silver, and smithsonite (Bullock, 1967, p. 38). There are no known reserves left in the mine.

Bullion Beck Mine

The Bullion Beck mine is located at the west end of Eureka in the bottom of Eureka Gulch. Its shaft collar is in NESWSE 13-10S-3W at an elevation of 6,390 feet (1,948m). The mine is one of the oldest in the district and was first worked in 1882. John Beck, one of the owners of the Eureka Hill mine, was cheated out of his share. Mr. Beck moved to the north of the Eureka Hill and started to sink a shaft in the alluvium in the bottom of Eureka Gulch. The local people laughed at him for his folly, but did not deter him from his effort. Bedrock was encountered at 130 feet (40m) and shortly thereafter the first blind ore body was discovered in the district. The mineralization is a northern extension of the ore cropping out on the Eureka Hill property. The mine is opened by a vertical shaft, 1,300 feet (396m) deept, and total workings are approximately 10 miles (16km) in length. The mine is credited with producing 252,671 tons of ore averaging 12 ounces in silver, 0.4 percent copper, 8.3 percent lead, and 0.2 percent zinc (Anonymous, 1957, pl. 3).

The mine workings are in the Bluebell Dolomite, Opex Dolomite, and Ajax Limestone. The ore bodies follow northerly fractures that closely coincide with bedding planes. The three ore body channels, the Gem, Tank, and Red Bird, come together south of the shaft. To the north they continue into the Gemini property. The siliceous silve-lead ores are largely oxidized, but some residual galena remains in the upper levels. There are no known reserves in the mine, some of the local miners feel highly about the potential of the property.

Eureka Hill Mine

The Eureka Hill mine is on the Gemini ore run and is located 2,200 feet (67m) south of Eureka between the Centennial-Eureka and Bullion Beck mines. It is in SWSESE 13-10S-3W at 6,510 feet (1,984m) above sea level. The Eureka Hill was the original 1870 discovery on the Gemini ore run and mine workings consist of two main shafts and several shallow shafts. There are also several short adits. There are approximately 11 miles (17.7 km) of workings in the mine which has a recorded production of 116,450 tons of ore with an average grade of 0.7 ounces in gold, 15 ounces in silver, 0.6 percent copper, and 5.6 percent lead (Anonymous, 1957, pl. 3).

The ore is in the Opex, Ajax, and Cole Canyon Formations and is associated with cross-faults. The ore forms irregularly shaped pipes along these faults. Minerals are cerussite, anglesite, cuprite, malachite, azurite, olivenite, enargite, tenantite, clinoclasite, limonite, pyrite, quartz, barite, and calcite. There are no known reserves in the mine.

Centennial-Eureka Mine

The Centennial-Eureka or Bluerock mine, as it is locally known, is about

4,000 feet (1,219m) southeast of the center of Eureka and 1,600 feet (488m) northwest of Eureka Peak. The shaft collar is in NWSENE 24-10S-3W at an elevation of 6,920 feet (2,109m). The mine was opened in 1876, but was not actively worked until 1886. It is the second most productive property in the district, after the Chief mine, and is known for large and continuous ore bodies rather than high-grade ore. The principal metals produced were gold, silver, and copper, and the value was divided evenly between the three. The mine is credited with producing 1,422,402 tons of ore averaging 0.4 ounces in gold, 12.6 ounces in silver, 2.4 percent copper, and 0.6 percent lead (Anonymous, 1957, pl. 3). The total mine workings total approximately 20 miles (32.1km).

The formations that contain the ore are the Cole Canyon and Opex Dolomites, and the Ajax Limestone. Two great easterly fractures are very important and have influenced the occurrence of ore south of the shaft. These fractures are designated as the first and second cross-breaks. Both dip 68 degrees to the south and ore occurs along them to great depths. On the first cross-break ore was mined from the 600 to the 1,500 levels and on the second cross-break ore occurs from near the surface to just above the 1,800 level. There are five northerly-trending fracture zones; the Gem, Eureka Hill New Years, Big Platform, and Never Sweat. The first three are continuous from the Eureka Hill ground and lie within a space of 300 feet (91m) of each other east to west. The latter two appear east and southeast of the shaft. The bulk of the ore contains copper, silver, and gold, and primary minerals include enargite and chalcopyrite. The copper ores locally contain much galena. Galena and enargite are found in the northern part of the property near the Eureka Hill boundary. Other minerals include cerussite, cerargyrite, malachite, native silver and gold, arsenates, native copper, cuprite, barite, quartz, pyrite, and jasperoid. There are no reserves remaining in the mine, but local miners feel that much ore remains to be discovered in the vicinity. The deep extensions of known shoots may present good explorational targets below the water table.

Grand Central Mine

The Grand Central mine is located about 4,000 feet (1,219m) northeast of the town of Mammoth and 2,000 feet (610m) north-northwest of the Mammoth shaft. The Grand Central shaft is in SENWSW 19-10S-2W at an elevation of 7.175 feet (2,187m) and is 2,300 feet (701m) deep on the Chief ore run. The property lies between the Victoria mine on the north and the Mammoth mine on the south. It is patented and owned by the McIntyre family. Underground workings total several miles. The ore body is a continuation of the Mammoth mine's Silveropolis stope, which flattens out and enters Grand Central ground on the 800 level and becomes known as the Butterfly stope. The ore was almost completely oxidized and consisted of native silver, cerargyrite, cerussite, anglesite, galena, chalcopyrite, chalcocite, covellite, argentite, malachite, azurite, and copper arsenates. Gangue minerals were limonite, pyrite, and barite. The lead was generally in the outer casings of the ore which had a high siliceous content. The Grand Central mine produced 488,292 tons of ore averaging 0.3 ounces in gold, 13.2 ounces in silver, 0.4 percent copper, 0.3 percent zinc (Anonymous, 1957, pl. 3). No reserves remain in the mine workings, but there are good explorational targets below and to the south.

Mammoth Mine

The Mammoth mine is 300 feet (91m) northeast of the town of Mammoth and is reached by a road that extends northeast from Mammoth townsite and ends at the Mammoth portal in NENESW 30-10S-2W at 7,100 feet (1,336m) above sea level. The mine was located in 1870 and first produced in 1872. It has been one of the more productive mines of the district and through 1957 produced 1,178,816 tons of ore averaging 0.1 ounces in gold, 11.1 ounces in silver, 1.6 percent copper, and 1.5 percent lead. The mine was shut down in the late 1950s and remained down until the summer of 1976 when Kennecott Copper Corporation leased it and put it back into operation. In the Fall of 1976 it was producing 100 short tons of flux ore per day being sent to Kennecott's smelter at Magna. Mine workings consist of a shaft 2,600 feet (792m) deep with several levels turned from it. There are several miles of workings in the mine and most of the ore above the 2400 level has been mined out. Several ore bodies have been worked in the mine and most are in the Mississippian Bluebell Dolomite at the intersections of two or more fractures striking north-northeast and northeast. The principal ore bodies are the Apex, Silveropolis, Golden King, and Welding shoots. The largest is the Apex shoot, a pipelike ore body that extends from the 100-foot level to the 2,100-foot level, dipping 70° NE with a width up to 100 feet (30m). The next largest is the Silveropolis shoot that begins near the surface dipping 60-80 degrees north-northwest to the 900 level at which point it flattens and enters the Grand Central property. Minerals found in the ores are native gold, native silver, native copper, argentite, malachite, azurite, argenojarosite, plumbojarosite, cerussite, anglesite, galena, enargite, chalcocite, covellite, cerargyrite, was, and famatinite. Gangue minerals are calcite, quartz, pyrite, limonite, hematite, brecciated limestone and dolomite, barite, clinoclasite, olivenite, and tyrolite. The amount of reserve is held confidential by Kennecott Copper Corp. but are located between the 2,400 and 2,600 levels and is presently being mined.

Gold Chain Mine

The Gold Chain mine is approximately 2,500 (762m) east of the town of Mammoth and 1,500 feet (457m) south-southwest of the Mammoth shaft. It is in NWSENW 30-10S-2W at an elevation of 6,900 feet (2,103m). The property was formerly known as the Copperopolis and American Eagle and later as the Ajax. These two companies are reported to have produced ore prior to 1890 to the net value of $1,000,000 (Lindgren and Loughlin, 1919, p. 218). The Ajax Mining Co. continued its operation through the Ajax shaft to the 1,000-foot level in 1907 and to 1,250 feet (381m) by 1911. Gross value of ore mined from 1899 to 1919 probably exceeded $3,000,000. The Gold Chain mine has produced 149,341 tons of ore averaging 0.3 ounces in gold, 5.3 ounces in silver, 3.5 percent copper, and 0.5 percent lead (Anonymous, 1957, pl. 3).

The mine is mainly cut in the Upper Cambrian Ajax Limestone, but lower workings extend into the Opex Dolomite. Three veins are opened in the mine; the Hungarian, the Ajax, and the Gold Chain. Mineralization occurs at the intersections of north-northeast and N. 25° E. trending fractures forming large bodies of ore with irregular boundaries. They extend as many horizontal shoots along the stratification for considerable distances beyond the main mass of ore. Ore in the upper workings was largely oxidized and carried much enargite and olivenite; the proportion of copper to other metals was unusually large and in places oxidation segregated the metals into separate ore bodies. Minerals in the mine are cerussite, anglesite, galena, argentite, tennantite, malachite, azurite, conichalcite, olivenite, tyrolite, pharmacosiderite, calcite, selenite, limonite, hematite, and quartz. There are no remaining reserves in the mine.

Lower Mammoth Mine

The Lower Mammoth mine is just east of the town of Mammoth and is southwest of the Mammoth mine. The portal of the adit leading to the underground shaft is in SWSWNW 30-10S-2W at an elevation of 6,730 feet (2,051m). The mine was opened in the early days by driving an adit 650 feet (183m) to a vein. An underground shaft was sunk from the end of the adit to a depth of 2,000 feet (610m). Drifts and crosscuts amount to several thousand feet. The workings of the Blackjack mine connect with the Lower Mammoth on the 1,300-foot level (1,000-foot level of the Lower Mammoth). Water was encountered on the 2,000-foot level. The mine is credited with producing 45,203 tons of ore averaging 17.8 ounces in silver, 0.6 percent copper, 4.4 percent lead, and 4.7 percent zinc (Anonymous, 1957, pl. 3). The mine is cut in the Upper Cambrian Ajax and Opex Formations. The ore bodies lie in two veins 150 feet (46m) apart; the east or Hungarian, and the west vein. Ore has replaced limestone forming pipe-like shoots. Small bunches of ore have been found in other places on the veins, which stand nearly vertical. The largest shoot is on the west vein and 500 feet (152m) south of the shaft extending from the 1,200 to the 1,800 levels. This shoot yielded a net value of $200,000. The ore in the lead shoots was largely oxidized and contained a trace of copper and a little zinc. Considerable smithsonite was present near these shoots due to secondary migration of zinc. Ore along the monzonite contact is distinctly different containing much pyrite, sphalerite, and a little galena, enargite, and tetrahedrite in a gangue of quartz, barite, and calcite. Heyl (1963, p. B76) reports that 100,000 tons of 12 percent zinc remained in the mine in 1917, but this ore may have been mined at a later date.

Plutus Mine

The Plutus mine workings are confined to the Plutus claims and were explored and mined through the Chief No. 2 shaft. The Chief No. 2 shaft is in NENWSE 18-10S-2W at an elevation of 6,690 feet (2,039m). The Plutus ore run was the last major ore trend to be discovered in the district. The Plutus claims, under which the ore run lies, are to the east of the Victoria mine and joins the Mammoth property to the south. The underground workings are also connected with the Mammoth mine workings. The Plutus is credited with ore production amounting to 229,239 tons averaging 2.9 ounces in gold, 25.8 ounces in silver, 0.4 percent copper, and 10.6 percent lead. The high ore grade produced is explained by the community lease system of mining in which the miners received a percentage of the profits by keeping the ore clean and the grade up.

The geology and ore deposits of the Plutus ore run are summarized by Morris (1968, p. 1059,1060):

> "The ore bodies of this zone are localized in the Fish Haven, Bluebell, and Victoria Formations, chiefly near fissures that are also mineralized in the Mammoth and Grand Central mines. The recurrence of the ore-bearing formations east of their exposures in the Grand Central, Victoria, and adjacent mines was not anticipated from the surface geology when the area was first explored in 1925 but was later determined to have been the result of disharmonic folding that produced a subsidiary anticline in

the rocks between the Centennial and Sioux-Ajax faults. This subsidiary fold is partly delimited on the west by an unobtrusive strike fault, which is named the Victoria fault from exposures in the lower levels of the Victoria mine.

The ore bodies in the southern part of the Plutus zone replace faulted and gently dipping beds in the Fish Haven, Bluebell, and Victoria Formations in the axial area of the disharmonic anticline at elevations of 5600 and 5700 feet. The principal ore bodies, which consist of partly oxidized argentiferous galena and jasperoid, replace selected bedding horizons 10 to 20 feet thick that bridge areas between the essentially unmineralized faults and fissures. Near the West fissure, which extends north-northeasterly from the workings of the Grand Central mine, the ore shoots extend through several fault blocks in the same favorable horizon at the top of the Bluebell Dolomite, erroneously suggesting post-mineral fault displacement.

In the central part of the Plutus zone, the ore bodies preferentially replace horizons in the upper part of the Bluebell Dolomite and in the Victoria Formation at elevations of 5300 to 5600 feet. In this part of the Plutus zone, the ore bodies are more obviously related to fissures, particularly the north-northeast trending Plutus fissure zone; however, many of them also extend outward for many feet on beds that strike northwest and dip northeast at 35°. Much rich siliceous silver ore was produced from shoots in this part of the Plutus mine.

The ore bodies in the northern part of the Plutus zone form gently northeast-plunging, en echelon, ore shoots that cut across the moderately dipping upper Bluebell and Victoria Formations. The southernmost and easternmost of these ore bodies are localized near the obscure Plutus fissure, and the others are similarly localized near noncontinuous en echelon fractures in the same zone. The northernmost shoot has been mined to a depth of 5200 feet. Extensive exploration in the northern part of the Plutus zone, particularly near the Centennial fault zone, was unsuccessful, suggesting that the principal access ways for the hydrothermal solutions were the north-northeasterly mineralized fissures that also localize the roots of the Mammoth, Grand Central, and Centennial-Eureka ore bodies."

A large tonnage of high grade ore was removed from the mine and it is suggested that much additional lower grade material was shipped, but credited to other mines. The area remains with a good potential for the finding of additional ore.

Iron Blossom Ore Run

The Iron Blossom ore run is easternmost in the district and parallels the Godiva ore run. Principal mines from north to south are the Beck, Colorado Consolidated, Sioux Consolidated, Iron Blossom, Governor, Dragon, Undine, and Martha Washington. The run has been named after the Iron Blossom mine, which lies near the Sioux-Ajax fault and was the largest producer on the run. The

Iron Blossom ore run has a recorded production of 1,353,122 tons. The geology and structure of the run is summarized by Morris (1968, p. 1060-1062):

> "The Iron Blossom ore zone originates in the same group of northeast-trending veins and fissures as the Godiva zone and similarly consists of veinlike deposits south of the Sioux-Ajax fault and more or less continuous replacement deposits in the Deseret Limestone north of the Sioux-Ajax fault zone.
>
> The principal veins cutting the Silver City stock that appear to be allied with the Iron Blossom zone are opened by the Undine and Martha Washington mines, no long abandoned. Neither these veins nor others in the same zone cross the contact of the monzonite and sedimentary rocks, but they are closely alined with Dragon vein which cuts the contact aureole near the Dragon mine. In the general vicinity of this mine, the ore shoots occur in the Ajax and Opohonga Formations and are chiefly valuable for gold; however, they also contain galena and enargite, or their oxidation products, in a gangue of jasperoid and barite.
>
> In the Iron Blossom No. 1 mine, the Dragon vein zone enters the Fish Haven and Bluebell Dolomites, and, in these more hospitable host rocks, the ore shoots show a greater tendency to replace wall rocks, some of them being 10 to 15 feet wide and 100 to 150 feet high. They are chiefly confined to elevations of 6700 to 6900 feet although the roots of some ore bodies have been followed downward to an elevation of 6200 feet. The main ore zone continues northward at this horizon for a third of a mile or more, maintaining the same general dimensions and character. These ore bodies have yielded large amounts of gold, copper, silver, and lead ores.
>
> Near the Iron Blossom No. 3 shaft, the Iron Blossom ore zone crosses the Sioux-Ajax fault zone, which is approximately 300 feet wide and contains fractured and brecciated rocks of the Fitchville, Gardison, and lower Deseret Formations. In this disturbed zone, the continuity of the ore zone is disrupted, but an infaulted segment of the Gardison Limestone localizes the rich Van ore body, which extends for 50 feet above and 60 feet below the 480-foot level.
>
> North of the Sioux-Ajax fault zone, the ore bodies enter the horizon of coarse bioclastic limestones in the upper part of the Deseret Limestone and extend without interruption for nearly a mile straight north, following the nearly flat beds in the axial area of the Tintic syncline. This shoot may be considered to be a horizontal pipe nearly a mile in length, lying at altitudes ranging from 6800 to 6900 feet. Although no vein structures are visible, the ore body appears to have formed at the intersection of vertical tension fissures and the susceptible "ore beds" that are also the host rocks for the replacement ore bodies of the adjacent Godiva zone. The ore pipe is conformable to the stratification and has a width of 20 to 170 feet and a height of 20 to 60 feet. In many places, the high-grade silver and lead ore bodies are adjoined by large masses of dark jasperoid, which has been the source of much siliceous fluxing ore. Oxidation and leaching of the ore body resulted in the development of a shrinkage cavity above the ore body that made it possible for the miners to walk for long distances through an open cave between the top of the oxidized ore body and the limestone country rock during the initial development of the ore body.

Near the northern end of the horizontal pipe, between the Beck No. 1 and No. 2 shafts, the ore shoots leave the axis of the syncline at an elevation of about 6800 feet and extend upward to the northwest along the dip of the ore-bearing limestone beds, in part following a system of obscure cross fractures. The ore bodies become more irregular in size and less continuous, but the mineralized zone persists northwesterly until it joins the Humbug ore bodies of the Godiva ore zone, which lie 200 to 500 feet higher in elevation. Extensive exploration on projection of the horizontal pipe in the Beck Tunnel No. 2 mine has failed to disclose any continuation of the Iron Blossom ore body."

The Iron Blossom run is known for its high-grade silver-lead oxidized ore. Minerals found in the mines on the northern end of the run are anglesite, calamine, cerussite, sphalerite, galena, smithsonite, cerargyrite, minium, stephanite, hydrozincite, native silver and gold, aurichalcite, azurite, malachite, geocronite, covellite, enargite, pyrite, dolomite, jasper, calcite, limonite, adamite, aragonite, and barite (Bullock, 1967, p. 38-39). The mines in the southern part of the run have aurichalcite, azurite, brochantite, chrysocolla, conichalcite, native copper, cuprite, malachite, bismuth, bismutite, mixite, enargite, lettsomite, barite, calcite, garnet, olivenite, pitticite, scorodite, and utahite. The reserves of the Iron Blossom ore run are kept confidential by Kennecott Copper Corporation's Tintic Division. Remaining is siliceous low-grade lead-silver ore. Additional ore bodies along the run may be found at greater depths (see table 21).

Godiva Ore Run

The Godiva ore run parallels that of the Iron Blossom for most of its length to the west. The run starts in Ruby Hollow and is expressed as a wide zone of northeast-trending veins and fissures in the Silver City stock. The zone continues northeasterly to the Sioux-Ajax fault and becomes a tabular replacement mass that persistently follows an horizon in the carbonate rocks for more than 5,000 feet (1,542m) to the Humbug mine. The zone continues northerly through the Humbug in to the Yankee and Godiva mines. The mines along the run, north to south, include the Godiva, May Day, Yankee, Uncle Sam (Humbug), Salvator, Northern Spy, Carisa, Victor, Red Rose, Boss Tweed, and North Star. The run has a recorded production of 507,162 tons. The geology and structure of the run has been summarized by Morris (1968, p. 1060):

> "...The dominant veins on the western side of the fissure and vein zone in the monzonite were opened by the Sunbeam, Elmer Ray, and other mines. These veins do not cross the contact but are more or less alined with replacement veins exposed to the North Star, Red Rose, Boss Tweed, Victor, Carisa, and Northern Spy mines that cut the Ajax, Opohonga, Fish Haven, Bluebell and Victoria Formations. The replacement veins in the latter mines range from narrow seams cutting marbleized and silicated carbonate rocks to zones 30 or more feet wide that principally occur near fissure intersections in areas of less bleached and altered dolomite. The vertical range of the ore shoots of the replacement veins is small, extending in the Carisa mine area from the surface at an elevation of 7500 feet to an elevation of 6800 feet and from the surface in the North Star mine area to an elevation of about 6600 feet.
>
> North of the Sioux-Ajax fault, the ore bodies of the Godiva zone consist of tabular and podlike replacement masses that persistently follow a selected horizon of bioclastic limestone in the upper part of the Deseret Limestone for more than 5000 feet to the Humbug mine, where the ore zone is intersected by the northern or "connecting" ore bodies of the Iron Blossom zone. Between the Northern Spy and Humbug mines the ore bodies of the Godiva zone are 2 to 50 feet wide and are essentially confined between elevations of 7000 to 7300 feet in beds that strike north and dip east at 30° to 60° into the trough of the Tintic syncline.
>
> North of the Humbug mine, the ore bodies of the Godiva zone continue northerly along the strike of the favorable horizon to the Yankee mine. In this area, the ore zone is cut by many northeast-trending fractures of small displacement, and ore bodies become larger and extend through a greater vertical range, chiefly following the dip of the beds. Despite the influence of the Yankee fissure zone, the ore bodies continue north along the ore beds into the Godiva mine, where a series of strong faults cross the ore zone. Here the ore zone divides, one subzone crossing the fissure and fault zone on northwest trending beds and extending to the Centennial fault zone. The other subzone, which has been more productive, plunges northward down the fissure zone to an elevation of 6300 feet, where the ore bodies diminish in size and become lower in grade. Extensive exploration for possible continuations of the Godiva ore zone north of the Godiva mine has not been successful."

The ore bodies in the northern end of the run are lead-silver-zinc and have been oxidized and secondarily enriched. Minerals found in the mines are anglesite, calamine, cerussite, smithsonite, minium, hydrozincite, sphalerite, galena, cerargyrite, native silver and gold, stephanite, aurichalcite, azurite, malachite, geocronite, covellite, enargite, pyrite, dolomite, jasper, calcite, limonite, adamite, aragonite, and barite. Minerals found in the veins in the southern part of the zone are aurichalcite, azurite, malachite, brochantite, chrysocolla, conichalcite, native copper, cuprite, enargite, lettsomite, bismuth, bismutite, mixite, barite, calcite, garnet, olivenite, pitticite, scorodite, and utahite.

The potential for finding additional ore in the run is good. Some siliceous lead ore remains in some of the stopes.

Swansea Mine

The Swansea mine is located on the north side of the abandoned townsite of Silver City in SWSWSW 36-10S-3W at an elevation of 6,160 feet (1,878m). The Swansea was one of the earlier mines and has produced 77,387 tons of ore averaging an unknown amount of silver, 0.1 percent copper and 4.4 percent lead (Anonymous, 1957, pl 3.). The workings consist of two shafts, one 940 feet (287m) deep from which levels were run at one-hundred foot (30m) intervals to the north and south along the vein. Water was encountered at 650 feet (198m) and a pump was installed on the 700-foot level. Mine workings total several thousand feet of drifts, crosscuts, raises and stopes. Presently the mine is inactive and has been abandoned for many years.

The Swansea mine is in the Silver City quartz monzonite stock. Mine workings are in the Swansea vein which strikes N. 10-15° W. and dips 70 to 90 degrees to the west. The vein has been worked for a strike length of 2,000 feet (607m) starting at the Four Aces shaft northward through Swansea ground to the summit of the ridge north of the main Swansea shaft. The vein ranges in width from 10 feet (3m) to a thin seamlet. Vein minerals are quartz, pyrite, galena, sphalerite, arsenopyrite, and their oxidation products. The oxidation products are localized in the upper 600 feet (183m) of the vein. The vein consists of bands of quartz and pyrite, massive or in well-formed crystals, around small vugs and in narrow bands or lenses of almost solid pyrite. Galena is concentrated in a few lenticular bands, either nearly pure or mingled with considerable pyrite. Quartz is generally not conspicuous in the galena bands. These bands, especially where marked by rows of central vugs, appear to lie along original fractures and are separated by sheets of quartz monzonite that are replaced partly or completely by quartz or pyrite. Broader bands probably filled open fractures and replaced intervening slabs of wall

Table 21: Average grades of ore from various mines of the Tintic mining district.

Mine	Production in short tons	Gold Ounces	Silver Ounces	Copper Percent	Lead Percent	Zinc Percent
Iron Blossom Ore Run						
Beck	50,839	0.1	4.7	---	20.6	---
Colorado	258,608	0.1	24.7	---	11.6	---
Sioux Consolidated	76,226	---	32.4	---	16.9	---
Iron Blossom	645,337	0.1	26.3	0.6	9.5	---
Governor	139	---	11.0	3.9	---	---
Dragon and Martha Washington	321,973	0.8	3.4	---	---	---
Undine	2,681	---	14.8	0.8	2.5	---
Godiva Ore Run						
Godiva	124,013	0.1	8.3	---	5.0	5.0
May Day	95,281	0.1	9.5	---	13.5	2.7
Yankee	103,191	0.1	14.8	---	1.5	1.5
Uncle Sam (Humbug)	110,842	0.1	17.0	---	1.0	0.2
Salvator	493	0.7	26.7	0.1	3.0	---
Utah	5,860	0.1	11.9	0.1	3.1	---
Northern Spy	?	?	?	?	?	?
Carisa	55,527	0.1	6.0	4.9	0.1	---
Victor Group	11,955	0.1	6.0	8.9	0.2	---
Red Rose, Boss Tweed, and North Star	?	?	?	?	?	?

---or ?: not reported

Source: Anonymous, 1957, pl. 3

rock (Lindgren and Loughlin, 1919, p. 255). No reserves remain in the mine but local miners feel that good ore targets remain on the Swansea claims.

Sunbeam Mine

The Sunbeam mine is the oldest in the district and is found 1 mile (1.6km) east of Silver City on the north side of Ruby Hollow in SWNESW 31-10S-2W at an elevation of 6,530 feet (1,990m). Mineralization was discovered in 1869 on a vein that strikes north to N. 35° E. and dips vertically to 60 degrees to the west. The vein can be traced on the surface for 2,500 feet (764km). Workings along the vein consist of 17 shafts and 2 adits, ore minerals are cerussite, galena, malachite in a gangue of pyrite and quartz. Mine workings extend to a depth of 490 feet (149m) where the water table was encountered. Vein width ranges to a maximum of 10 feet (3m), production for the Sunbeam was 7,371 short tons of ore averaging 12.5 ounces in silver, 1.8 percent copper, 1.9 percent lead (Anonymous, 1957, pl. 3). The vein has yielded over $500,000 in oxide ore, but there are no reserves remaining in the mine.

Undine Mine

The Undine mine is about 1 mile (1.6km) east of Silver City in SWNWSE 31-10S-2W at 6,510 feet (1,984m) above sea level. The workings consist of three shafts and an adit. The main shaft is 350 feet (107m) deep and the adit is about 800 feet (244m) long along a vein striking N. 30° E. and dipping 60-80° W. Total workings consist of approximately 3,000 (914m) feet. Production for the Undine mine is listed at 2,681 tons of ore averaging 14.8 ounces in silver, 0.8 percent copper, and 2.5 percent lead (Anonymous, 1957, pl. 3). Minerals found in the Undine are argentiferous galena, cerussite, and malachite occurring in a gangue of pyrite and quartz. There are no reserves remaining in the mine.

Joe Bowers-Showers Group

The Joe Bowers mine is located one mile (1.6km) north of the abandoned townsite of Diamond in NWSESW 5-11S-2W at an elevation of 6,590 feet (2,009m).

These claims are patented, the name of the owner undetermined. Mine workings are along a vein striking N. 10° E., dipping steeply to the west. There are several shafts and prospects along the vein. The water table was reached in the workings at a depth of 175 feet (53m), ore in the upper parts consisted of galena in a gangue of pyrite and quartz. Near the 200-foot level a body of enargite was found associated with the galena. Total mine workings are about 3,500 feet (1,069m) in length. Recorded production for the group is 8,123 tons averaging 11.6 ounces in silver, 0.5 percent copper, and 3 percent lead (Anonymous, 1957, pl. 3).

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Trout Creek District

The Trout Creek mining district is located on the east side of the Deep Creek Mountains near the mouth of Trout Creek Canyon in western Juab County. It is 75 miles (120.6km) west-northwest of Delta and 4 1/2 miles (7.2km) northwest of the town of Trout Creek. The district has not been a significant producer of lead and zinc. Only one mine has produced the commodities; the district is credited with 93 tons of lead-zinc ore, which contained 2,800 pounds lead, 29,000 pounds zinc, and 225 ounces of silver valued at $3,277 at the time of production (table 22). The most important mine of the district is the Trout Creek mine.

In the Trout Creek area Precambrian metamorphic rocks are thrust over Middle Cambrian units (figure 81). Precambrian rocks consist of interbedded schists, schistose quartzites, and quartzite. The Middle Cambrian strata consist of limestones and dolomite along with an occasional quartzitic unit. Mineralization is in Precambrian metamorphics forming a dome surrounding an alaskite intrusive (Thomson, 1973, p. 51). The contact mineralization contains sphalerite and scheelite in a gangue of typical contact minerals. Small reserves are present in the Trout Creek mine and exploration in surrounding areas may uncover additional mineralization.

Trout Creek Mine

The Trout Creek mine is located 1 mile (1.6km) northwest of Bobcat Ranch, the portal is in SWNENW 28-12S-18W at an elevation of 6,540 feet (1,993m). The mine has been mapped and described by Thomson (1973):

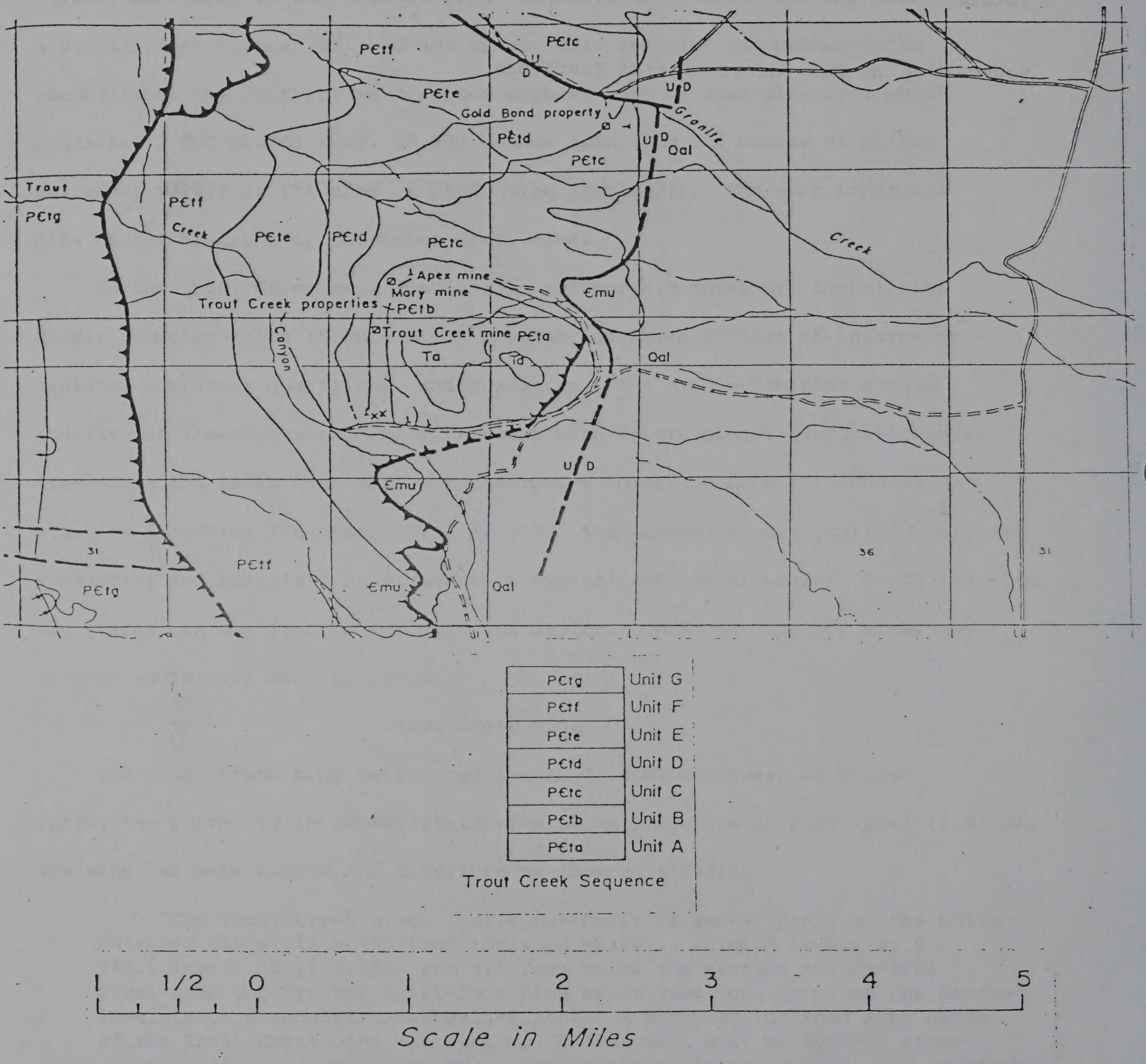
> "The Trout Creek mine, 1 mile northwest of Bobcat Ranch on the Shilo patented claim, is a 450-foot inclined shaft... ...with levels at 0 (adit level), 60,120,180, and 415 feet below the surface and several cross-cuts and drifts. A 28-foot high by 45-foot long stope of the 60-foot level is on a sphalerite-scheelite zone. A prospect inclined adit south of the Trout Creek mine was sunk to 30 feet with a 4- by 20-foot stope inclined 25° W. Lesser prospects lie in the vicinity of these two workings.
>
> In the Trout Creek mine, sphalerite, scheelite, and fluorite have been deposited in erratic pockets along N. 60° W. striking fault in the unit B dolomite. The small prospect inclined shaft south of the Trout

Table 22: Production of lead, zinc, and silver, Trout Creek district

Year	Tons of Ore	Lead/Pounds	Zinc/Pounds	Silver/Ozs.	Value
1942	41	---	15,000	59	$1,437
1943	52	2,800	14,000	166	1,840
Totals	93	2,800	29,000	225	$3,277

Source: U. S. Bur. Mines Mineral Yearbooks

Figure 81:
GEOLOGIC MAP OF THE TROUT CREEK DISTRICT



Adapted from Thomson, (1973), plate 2

> Creek mine is in a contact metasomatic zone within unit B dolomite. Minerals identified in this zone are muscovite, biotite, beryl, fluorite, quartz, dolomite, limonite, garnet, actinolite, and psilomelane."

A mine map and accompanying section by Thomson is shown in figure 82. Reserves left in the mine amount to 50 tons of zinc-tungsten ore, additional exploration and development from the mine and surrounding area has a good chance of increasing this figure substantially.

Apex Mine

The Apex mine is in the first small canyon north of Trout Creek Canyon, its portal is in SWNWSE 21-12S-18W at an elevation of 6,720 feet (2,048m). The Apex is a tungsten mine containing minor amounts of zinc (figures 83 and 84). Presently no lead-zinc reserves can be credited to the mine.

> "The Apex property, consisting of the Sun, Mineral, Merry and Metal patented claims and the Battle, Bear, Final, Dandy and Chief unpatented claims... ...lie in the north part of the Trout Creek area, 1 1/2 miles northwest of Bobcat Ranch. The Mary and Sport claims adjoin the Merry and Mineral claims on their south sides.
>
> The Apex tungsten mine, a 220-foot adit with an inclined 40-foot winze sunk 45 feet from the portal, lies in the southwest part of the Mineral claim. A 40-foot adit was driven N. 5° E. on the north side of an open pit, 200 feet north of the Apex mine. Several scattered cuts and prospects are on the Mineral patented claim. The 70-foot Apex east adit is 1,500 feet east of the Apex mine. In 1961-1962, Western Beryllium Co. drilled nine holes 70 to 272 feet deep to explore the mineralization on the Apex property. On the Sun patented claim, a small shaft and 10-foot prospect pit were dug in a limonite zone in schist.
>
> The Mary mine, a 165-foot inclined shaft at the north end of the Mary claim, bears N. 35° W. Seventy feet southeast of the Mary mine is the 35-foot Mary shaft. A quartz zone north and west of the Mary mine was trenched on the north end, explored by prospects on the west and cut for 25 to 30 feet, 1,100 feet to the southwest... (Thomson, 1973, p. 51)

References:

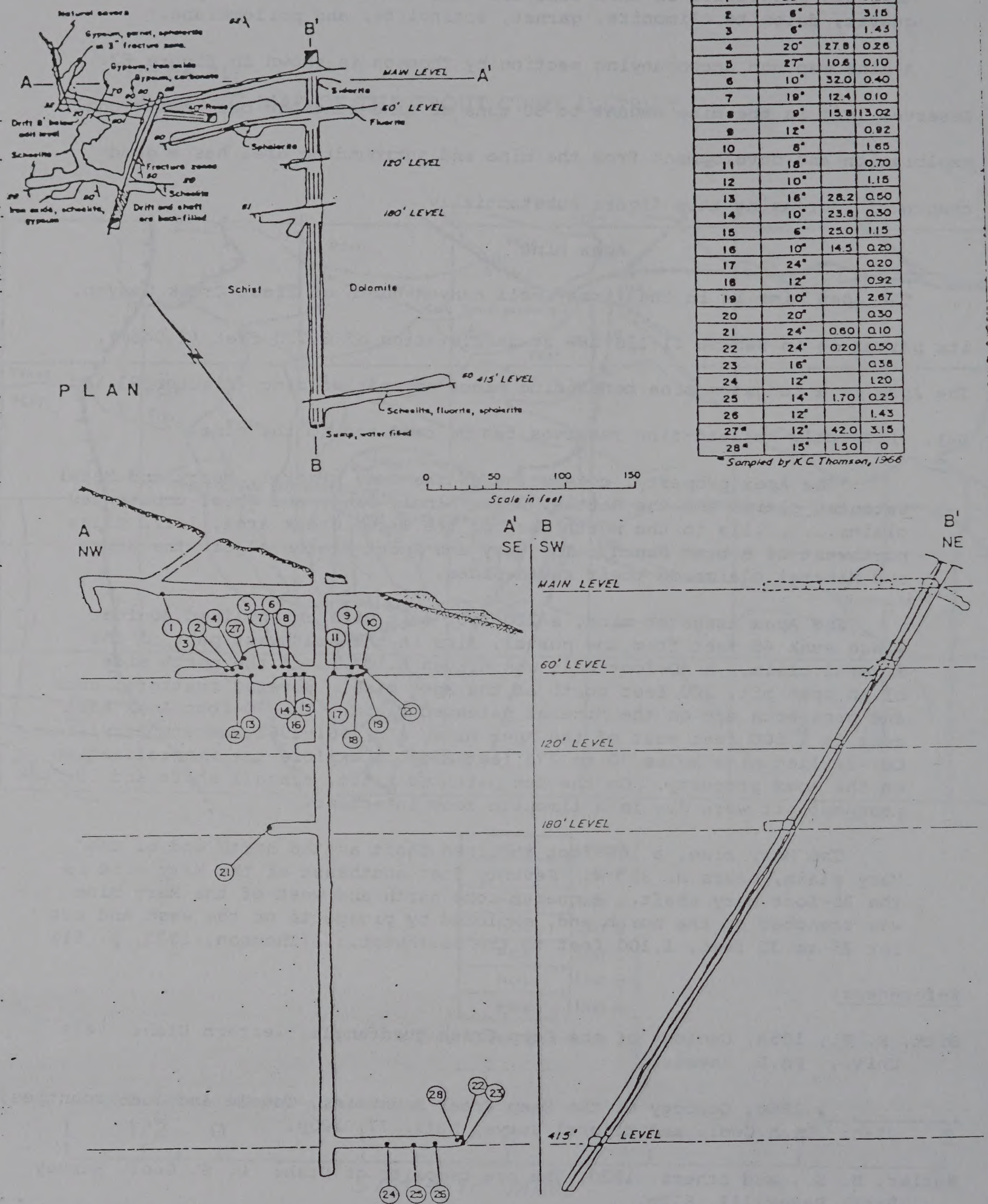
Bick, K. F., 1958, Geology of the Deep Creek Quadrangle, western Utah: Yale Univ., Ph.D. thesis.

___________, 1966, Geology of the Deep Creek Mountains, Tooele and Juab counties, Utah: Utah Geol. and Mineral Survey Bull. 77, 120p.

Butler, B. S., and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672p.

Hewitt, W. P., 1968, Western Utah, eastern and central Nevada-Utah and eastern Nevada in Ore deposits of the United States, 1933-1967: Graton-Sales, v. 1, Ch. 44, p. 857-882, Amer. Inst. of Mining Engineers.

TROUT CREEK MINE



ASSAYS:

SAMPLE NO.	LENGTH OF CUT	Zn %	WO3 %
1	35"		0.25
2	6"		3.15
3	6"		1.43
4	20"	27.8	0.26
5	27"	10.6	0.10
6	10"	32.0	0.40
7	19"	12.4	0.10
8	9"	15.8	13.02
9	12"		0.92
10	8"		1.65
11	18"		0.70
12	10"		1.15
13	16"	28.2	0.50
14	10"	23.8	0.30
15	6"	25.0	1.15
16	10"	14.5	0.20
17	24"		0.20
18	12"		0.92
19	10"		2.67
20	20"		0.30
21	24"	0.60	0.10
22	24"	0.20	0.50
23	16"		0.38
24	12"		1.20
25	14"	1.70	0.25
26	12"		1.43
27*	12"	42.0	3.15
28*	15"	1.50	0

* Sampled by K. C. Thomson, 1966

Longitudinal Projection Section Along Vein

Cross Section Through the Vein and Shaft

Figure 82: Plan and sections with geology and assay data of the Trout Creek mine.

Mine map and section adapted from Thomson, (1973) p.55

GEOLOGIC MAP AND SAMPLE LOCATION, A MINE AREA

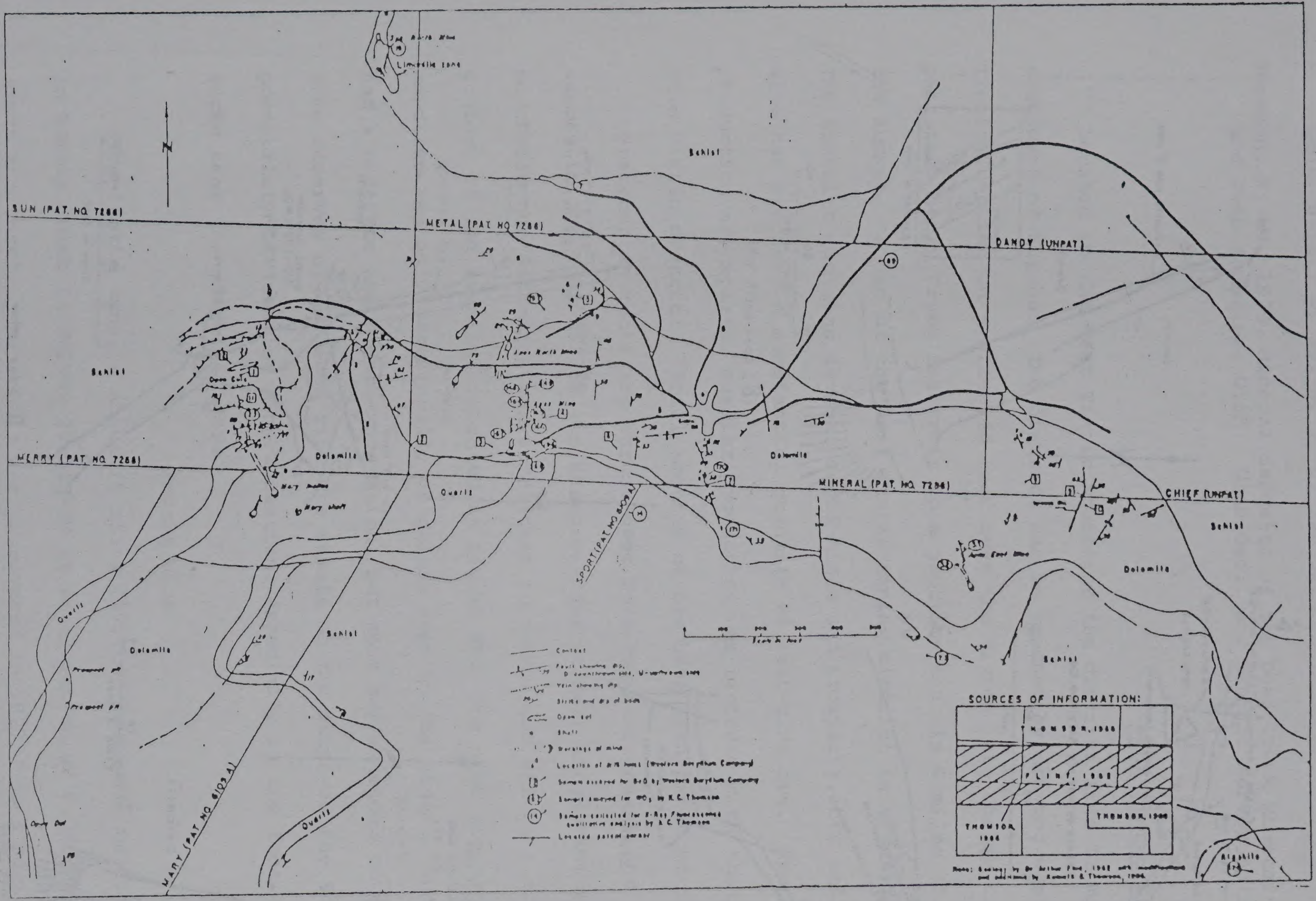
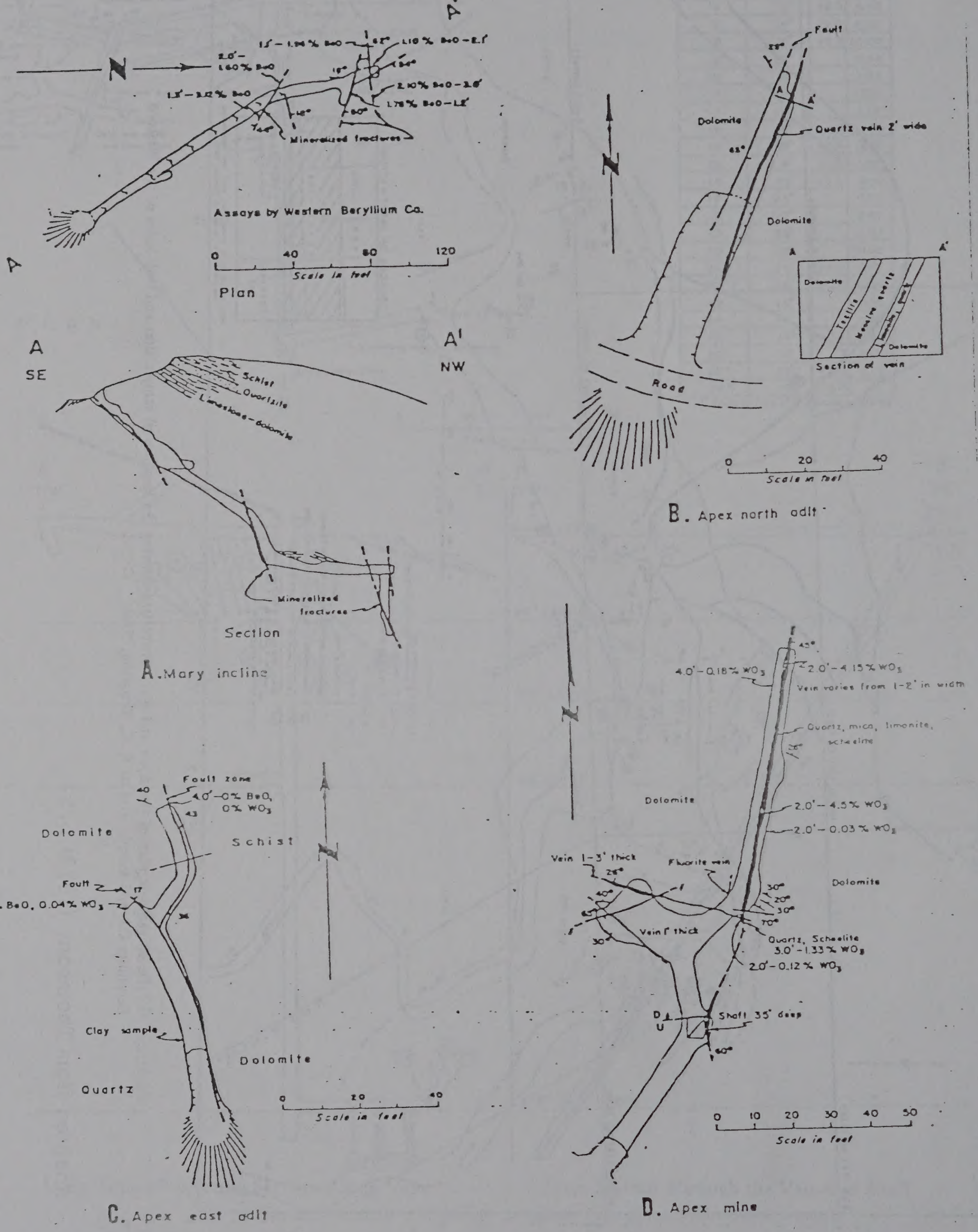


Figure 83: Detail geologic map of the Apex and Mary properties showing the location of sample sites and drill holes of the Western Beryllium Co. and sample sites of K. C. Thomson, 1968.

Adapted from Thomson, (1973) p.52

MINE MAP AND SECTION OF APEX MINE



A. Mary incline

B. Apex north adit

C. Apex east adit

D. Apex mine

Figure 84: Geology and workings of the mines in the Apex and Mary properties showing assay data.

Adapted from Thomson (1973), p. 53

Nelson, R. B., 1966, Structural development of northernmost Snake Range, Kern Mountains and Deep Creek Range, Nevada and Utah: Am. Assoc. Petrol. Geol. Bull., v. 50, n. 5, p. 921-951

Thomson, K. C., 1973, Mineral deposits of the Deep Creek Mountains, Tooele and Juab Counties, Utah: Utah Geol. and Mineral Survey Bull. 99, 76p.

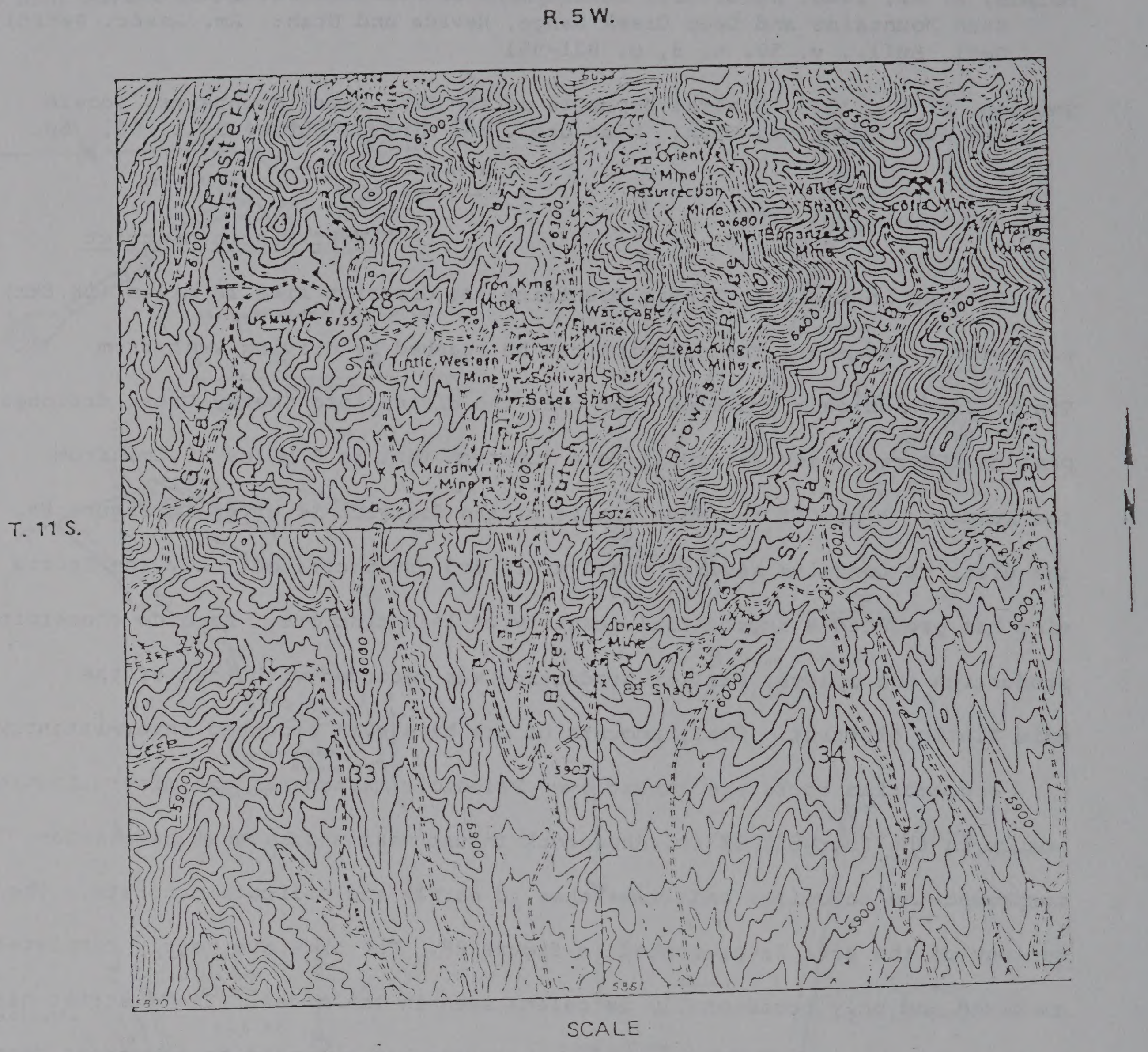
West Tintic District

Located in the West Tintic Mountains the district lies 18 miles (28.8km) southwest of Eureka. The district can be reached by driving west from Tintic Junction on a graveled road over the divide into Cherry Creek drainage past the Cherry Creek Reservoir to a junction that is 6 miles (9.6m) from the summit. A map of the West Tintic mining district is given in figure 85. The district contains several small mines and prospects, but only the Scotia mine has produced a substantial quantity of lead-zinc ore. Records concerning production are sparse, earlier production was recorded with that of the main Tintic district. Small amounts of ore have been produced intermittently.

Precambrian rocks are thrust over Paleozoic carbonates and mineralization occurs in the footwall of the Sheeprock thrust near stocks that have metamorphosed the dolomites and limestones to marble and silicate minerals. The geology of the area is presented in figure 86. The ores are nearly completely oxidized and only occasionally is galena seen in the mines. The district has had a moderate amount of exploration, but none has extended to any great depth. Some reserves of oxidized zinc ore remain on the dumps of the Scotia mine. The possibility of locating mineralization, especially in the footwall carbonate rocks near the stock, is good.

Scotia Mine

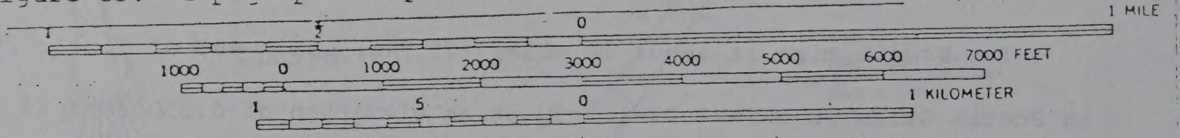
The Scotia mine is about 16 miles (25.7km) southwest of Tintic Junction in Scotia Gulch in NWSWNE 27-11S-5W at an elevation of 6,350 feet (1,935m) above sea level. The Scotia was discovered in 1870 when a pocket containing approximately 250 tons of 65 percent lead was found. This ore was shipped



WEST TINTIC DISTRICT

1. Scotia mine

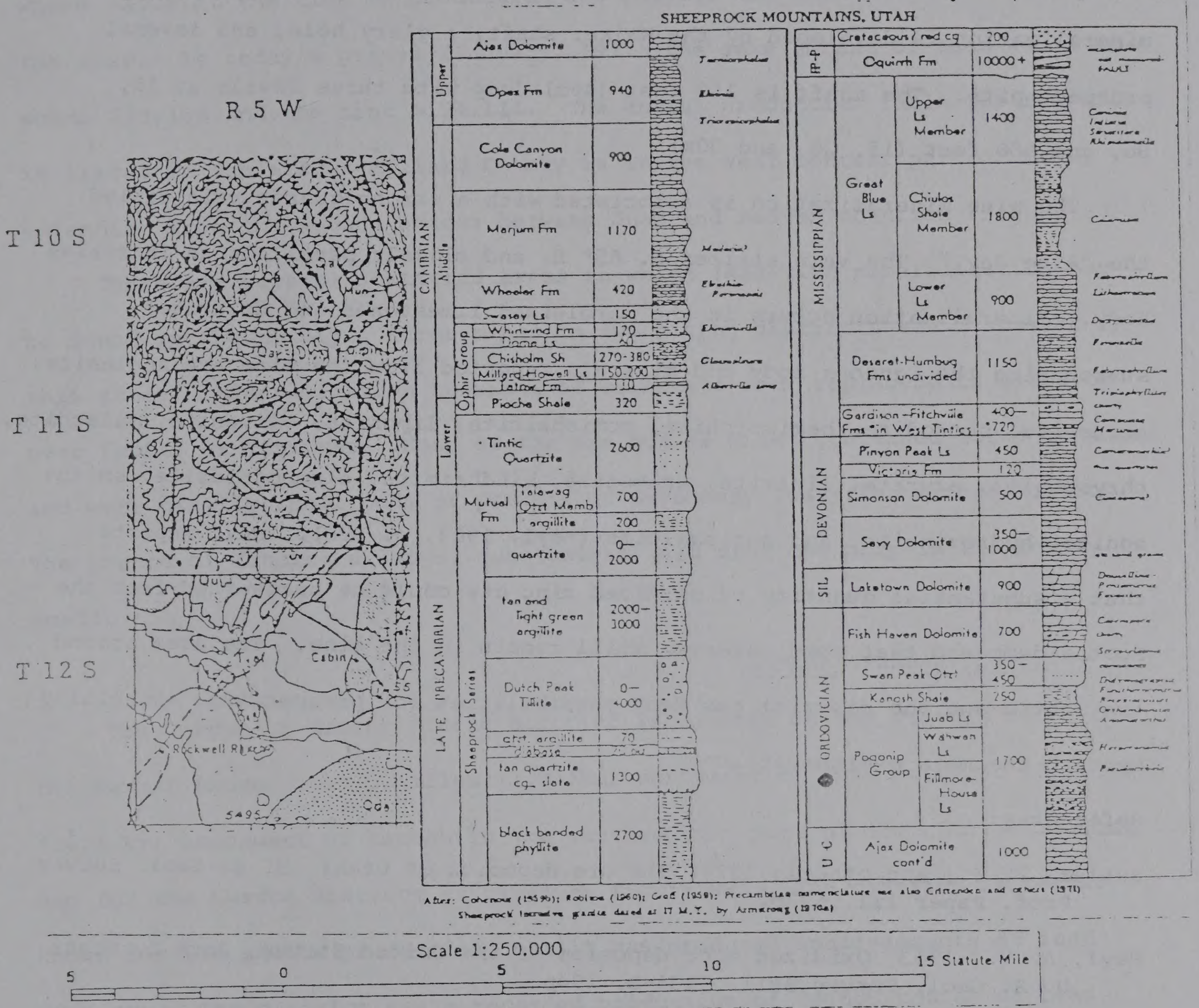
Figure 85: Topographic map of the West Tintic mining district



Adapted From: USGS Cherry Creek 7½' Quadrangle

Figure 86

GEOLOGIC MAP OF THE WEST TINTIC MINING DISTRICT



After: Cohenour (1959b); Robison (1960); Groff (1959); Precambrian nomenclature see also Crittenden and others (1971)
Sheeprock intrusive granite dated at 17 M.Y. by Armstrong (1970a)

● Ore-bearing horizon

Adapted from northwest quarter Geologic map of Utah 1:250,000 and Hintze, 1973, Geologic history of Utah, p. 135.

to Swansea, Wales, and to smelters south of Salt Lake City. The amount of ore produced before 1880 is unknown, but production since is estimated at 3,000 tons valued at $150,000 (Butler and others, 1920, p. 439). The mineralization is developed by the Walker shaft, a glory hole, and several prospect pits. The shaft is 150 feet (46m) deep with three levels at 50, 86, and 100 feet (15, 26, and 30m).

The mine mineralization is associated with a strong quartz vein called the "Blue Jay." The vein strikes N. 65° E. and closely parallels an intrusive body. Mineralization occurs in the marbleized limestones and dolomites surrounding the igneous body and minerals reported from the mine are anglesite, cerussite, scorodite, hemimorphite, conichalcite, limonite, olivenite, malachite, chrysocolla, azurite, linarite, aragonite, bindheimite, plumbojarosite, smithsonite, hydrozincite, and aurichalcite (Heyl, 1963, p. B78). Heyl reports that a substantial quantity of oxidized zinc ore could be handsorted from the Scotia dump and that some reserves still remain in the mine. The area around the Scotia and the district has many possibilities for prospecting, especially beneath the main overthrust zone.

References:

Butler, B. S., and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672p.

Heyl, A. V., 1963, Oxidized zinc deposits of the United States, Part 2, Utah: U. S. Geol. Survey Bull. 1135-B, 104p.

MILLARD COUNTY

Millard County has produced a small amount of lead and zinc. The recorded production is at least 348,710 pounds of lead and 416,515 pounds of zinc whose value at the time of production was $26,140 for the lead and $44,555 for the zinc. At today's prices (January, 1977) the same amount of lead would be worth $93,168 and the zinc $154,111. The annual production table for the county is listed in table 23. Millard County is in the west central part of Utah, extending from the Nevada border between Juab and Beaver counties (figure 87).

There are several scattered areas in which lead-zinc mineralization may be found in the county. Three mines in two mining districts are discussed in this study. Mineralization consists of carbonate rock replacements along or near faults or fissures. None of the ore bodies mined contained large tonnages and were usually small pods or pockets of secondary lead-zinc mineralization. The chance of finding a large, substantial lead-zinc ore body in the county is small.

Gordon (Kanosh) District

The Gordon or Kanosh mining district is located on the western slope of the Pavant Range about 12 miles (1,913km) northeast of Cove Fort and 10 miles (16.1 km) southwest of Kanosh in the southeastern part of the county. A location map for the Gordon district is given as figure 88. The district is better known for its sulfur production, but it has produced small amounts of lead-zinc ore. The district has a recorded production of 31,600 pounds of lead and 4,700 pounds of zinc, most was mined between 1948 and 1955. The principal mine is the Blue Bell.

Rocks in the Pavant Range range from Cambrian to Tertiary in age and in the vicinity of the Blue Bell mine Paleozoic rocks have been thrust over Mesozoic strata (figure 89). Mineralization is associated with a northeast-trending normal fault that has brecciated carbonate rocks in the upper plate of the thrust. This suitable location for the deposition of lead-zinc mineralization

Table 23: Production of metals from Millard County, 1905-1976

Year	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1905	35,000	---	25,000	190.00	10,199	$15,859
1906	40,000	---	30,656	607.30	3,005	22,991
1907	10,000	---	54,401	743.00	3,168	29,042
1908	no production					
1909	4,000	---	90,000	112.70	3,503	16,048
1910	no production					
1911	15,155	---	1,411	58.73	905	2,552
1912	---	---	2,966	9.00	283	849
1913	6,193	---	36	---	12	286
1914	no production					
1915	---	---	968	44.41	82	1,129
1916	7,901	---	3,834	1.11	65	1,554
1917	8,322	---	16,267	18.62	374	5,850
1918	---	---	3,795	3.72	---	1,014
1919	---	---	---	2.23	---	46
1920-1924	no production					
1925	18,938	36,215	---	---	140	4,497
1926	87,617	---	---	---	614	7,392
1927	no production					
1928	35,987	---	283	---	368	2,344
1929	3,349	---	---	0.05	13	219
1930	7,760	---	2,938	2.03	65	837
1931	---	---	---	4.11	---	85
1932	---	---	249	24.28	77	540
1933	---	---	2,345	161.91	421	3,644
1934	---	---	912	38.91	158	1,535
1935	---	---	22,313	535.80	1,109	21,402
1936	3,565	---	25,728	258.20	2,687	13,649
1937	9,610	---	4,810	56.00	234	3,290
1938	2,413	---	1,184	12.00	48	678
1939	---	---	---	55.00	9	1,931
1940	1,300	---	575	106.00	24	3,857
1941	1,900	---	700	400.00	315	14,415
1942	1,000	88,000	15,300	84.00	1,028	13,773
1943	200	103,500	---	4.00	---	11,333
1944	1,800	43,500	---	---	7	5,108
1945	no production					
1946	---	---	---	7.00	---	245

Table 23 continued

Year	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1947	---	---	---	10.00	---	$350
1948	13,400	700	100	13.00	94	3,053
1949	5,200	---	500	1.00	52	1,003
1950	5,600	100	3,800	6.00	210	1,960
1951	3,000	---	700	1.00	42	761
1952			no production			
1953	---	---	---	9.00	1	316
1954			no production			
1955	8,000	4,000	---	---	192	1,858
1956			no production			
1957	---	---	100	11.00	28	440
1958-1959			no production			
1960	500	8,100	300	2.00	23	1,291
1961	800	85,100	---	---	50	9,822
1962	---	26,300	---	---	44	3,072
1963	3,700	400	---	---	46	505
1964	4,400	4,300	1,100	3.00	428	2,178
1965	1,700	15,700	---	---	67	2,644
1966	400	600	---	---	2	150
1967-1976			no production			
Totals	348,710	416,515	313,271	3,596.11	30,192	$237,397

Rough estimates: 1905-1907, 1960-1966
All other years: U. S. Bur. Mines Mineral Yearbooks

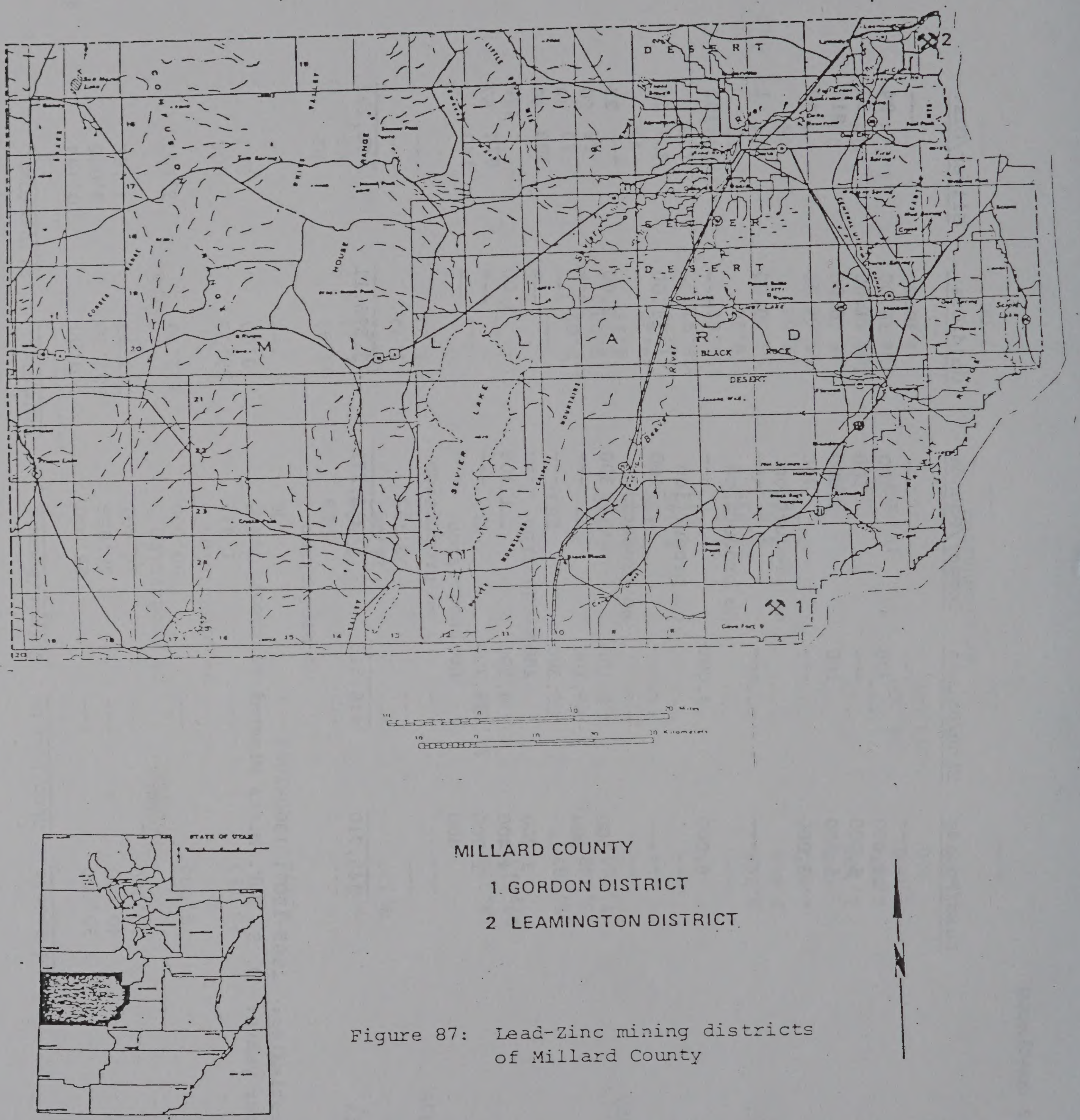
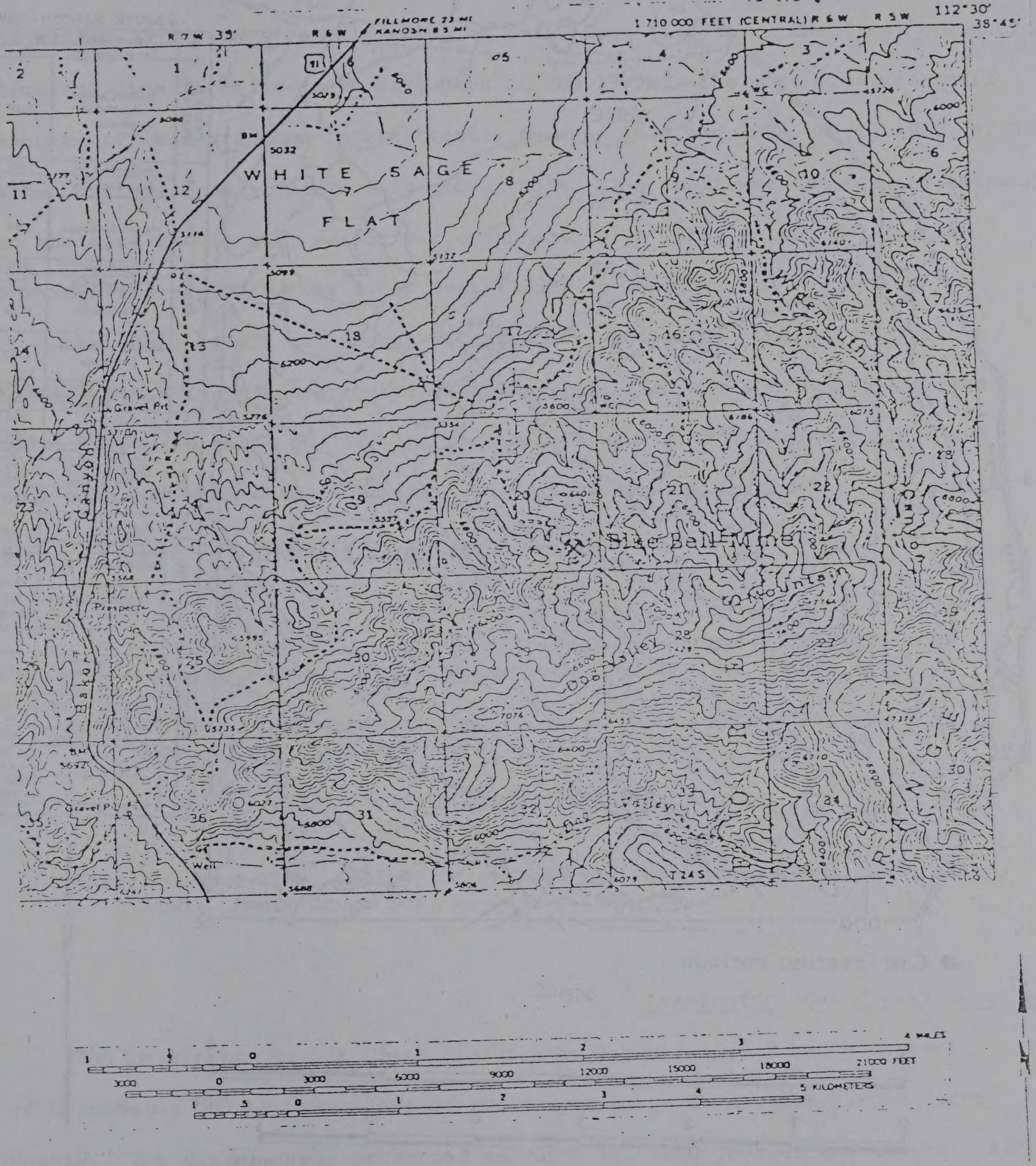


Figure 87: Lead-Zinc mining districts of Millard County

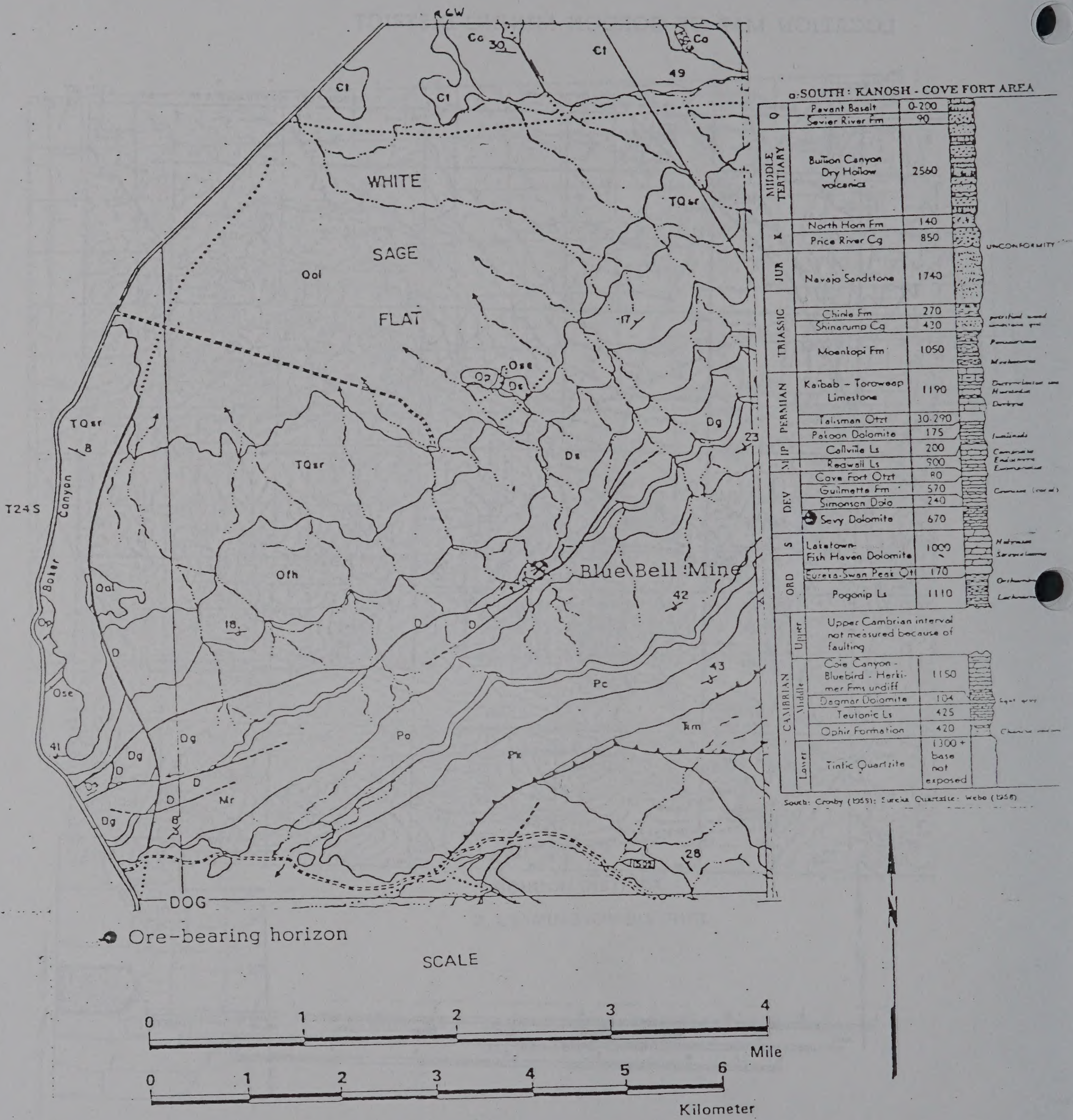
Figure 88

LOCATION MAP OF GORDON MINING DISTRICT



Adapted from U.S.G.S. Cove Fort 15' quadrangle

Figure 89:
GEOLOGIC MAP OF THE GORDON DISTRICT



a-SOUTH : KANOSH - COVE FORT AREA

Q	Pavant Basalt	0-200	
	Sevier River Fm	90	
MIDDLE TERTIARY	Button Canyon Dry Hollow volcanics	2560	
K	North Horn Fm	140	
	Price River Cg	850	UNCONFORMITY
JUR	Navajo Sandstone	1740	
TRIASSIC	Chinle Fm	270	
	Shinarump Cg	430	
	Moenkopi Fm	1050	
PERMIAN	Kaibab - Toroweap Limestone	1190	
	Talisman Qtzt	30-290	
	Pakoon Dolomite	175	
IP	Callville Ls	200	
M	Redwall Ls	900	
DEV	Cove Fort Qtzt	80	
	Guilmette Fm	570	
	Simonson Dolo	240	
	Sevy Dolomite	670	
S	Laketown-Fish Haven Dolomite	1000	
ORD	Eureka-Swan Peak Qt	170	
	Pogonip Ls	1110	
CAMBRIAN Upper	Upper Cambrian interval not measured because of faulting		
CAMBRIAN Middle	Cole Canyon - Bluebird - Herkimer Fms undiff	1150	
	Dagmar Dolomite	104	
	Teutonic Ls	425	
	Ophir Formation	420	
CAMBRIAN Lower	Tintic Quartzite	1300 + base not exposed	

South: Crosby (1959); Eureka Quartzite - Webb (1958)

Adapted from Geology of the south Pavant Range, Millard and Sevier Counties, Utah by G.W. Crosby, Stragraphic column from Geologic History of Utah by L.F. Hintze p. 151.

has been explored to shallow depths. The mineralization consists of secondary lead and zinc minerals containing an occasional pocket of residual sulfide.

Blue Bell Mine

The Blue Bell mine is located about 10 miles (16.1km) southwest of Kanosh in NWSESE 20-24S-6W at an elevation of 6,150 feet (1,874m). The first production from the mine is believed to have been in the 1920s. The mine produced small amounts of lead-zinc ore intermittently between 1925 and 1955 (Heyl, 1963, p. B87). Mine workings consist of an adit and a shaft. The shaft was the earlier entrance to the mine and an adit was driven underneath at a later date. Total mine workings are approximately 1,000 feet (305m) in length.

The workings are cut in the Silurian Sevy Dolomite. The adit follows a bedding plane fault and encounters the workings from the shaft about 40 feet (12m) below the shaft collar. Mineralization consists of secondary lead and zinc minerals with occasional small pockets of remnant sulfides. Additional exploration in the vicinity of the mine may develop more mineralization.

References:

Crosby, C. W., 1959, Geology of the south Pavant Range, Millard and Sevier Counties, Utah: Brig. Young Univ. M. S. thesis, 59p.

Heyl, A. V., 1963, Oxidized zinc deposits of the United States, Part 2, Utah: U. S. Geol. Survey Bull. 1135-B, 135p.

Hintze, L. F., 1973, Geologic history of Utah: Brig. Young Univ. Geol. St. v. 20, pt. 3, 181p.

Maxey, G. B., 1946, Geology of part of the Pavant Range, Millard County, Utah: Amer. Jour. Sci, v. 244, p. 324-356.

Leamington (Oak Creek) District

The Leamington or Oak Creek district is 4.5 miles (7.2 km) southeast of Leamington on the west slope of the Canyon Range in northeastern Millard County. The district was organized on March 11, 1886 (Butler and others, 1920, p. 422) and some of the first mined ore was sent to a local smelter; later ore was sent to the smelters near Salt Lake City. Only modest amounts of ore have been mined; Butler mentions 7 tons were shipped from the White Horse claim in 1901 and 350 tons were shipped from the Yellowstone claim between 1903 and 1906. The U. S. Bureau of Mines Mineral Yearbooks record that 3,565 pounds of lead were produced in 1936 and 1,087 pounds in 1938 (figure 90).

The Canyon Range contains rocks ranging in age from Precambrian to Ordovician (figure 91), and from the Cretaceous to the Tertiary. The mineralization occurs in the Cambrian carbonates where the rock has been brecciated by faulting and replacement has taken place. The mines in the district are shallow and mineralization consists of secondary lead and zinc minerals in a carbonate gangue. There are no known reserves in the mines of the Leamington district. A stratigraphic column is given for the Canyon Range in figure 92).

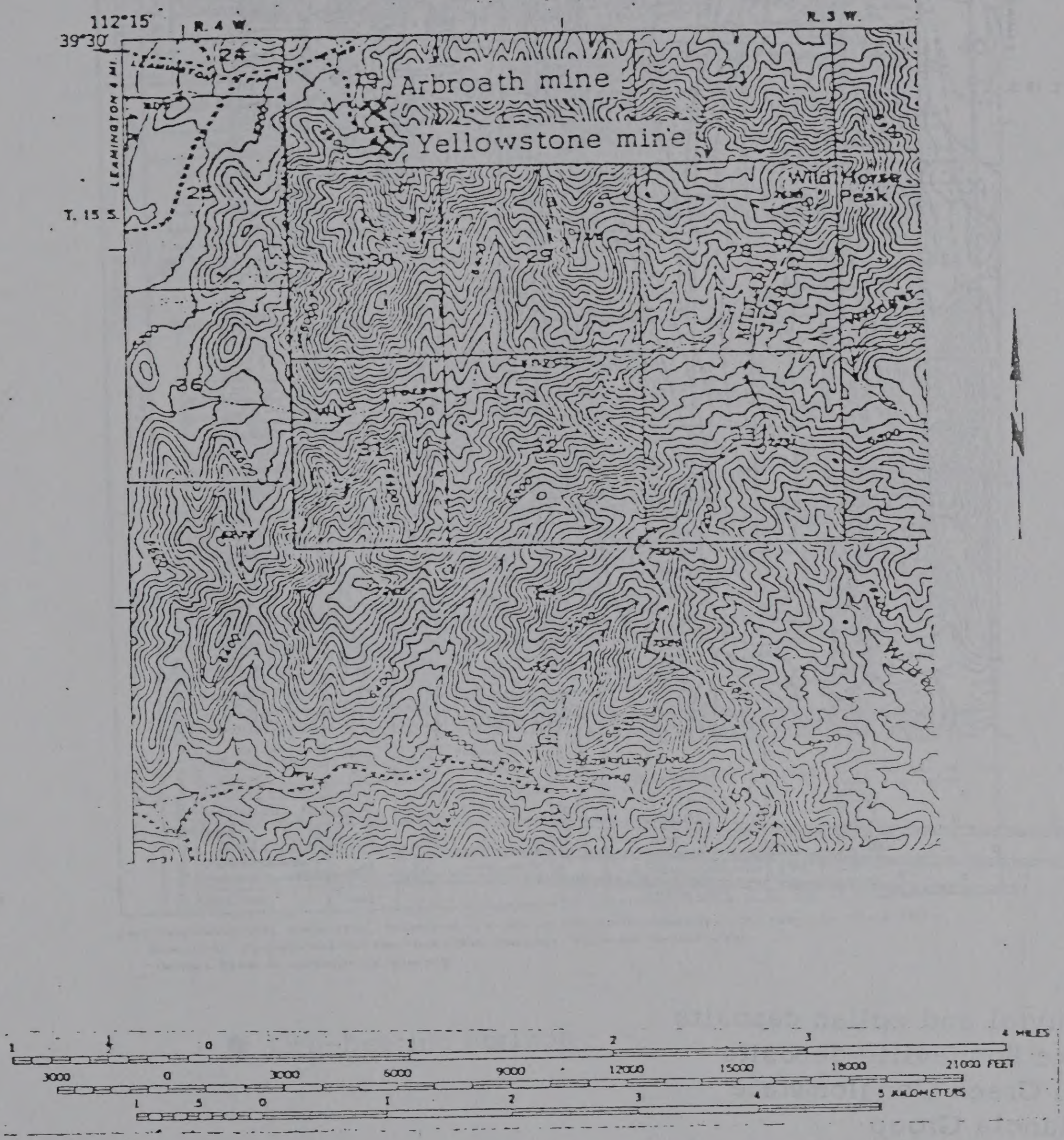
Arbroath Mine

The Arbroath mine is located about 4 miles (6.4km) southeast of Leamington and 1/8 of a mile (201m) north of the Leamington mine in SESWSE 19-15S-3W at an elevation of 5,400 feet (1,646m). Both the Arbroath and Leamington lie on the same north-south trending zone of mineralization. Mine workings consist of an inclined shaft and three vertical shafts. The size of the dumps suggest the mine might contain 1,000 feet (305m) of underground workings. There are no available production records and the output is thought to have been small. The mine workings are cut in Cambrian carbonate rocks. Mineralization is along a north-south trending zone of limonite-stained rocks and consisted of small pods and pockets of cerussite in a gangue of dolomite, aragonite, limonite, and calcite.

Yellowstone Mine

The Yellowstone mine is 4 miles (6.4km) southeast of Leamington in SESWSE 19-19S-3W at an elevation of 5,550 feet (1,691m). The mine has been worked intermittently and through 1920 produced 15 carloads of ore (Butler and others, 1920, p. 422). The original discovery was probably made in the latter part of the 19th Century. Workings consist of an inclined shaft 200 feet (61m) deep

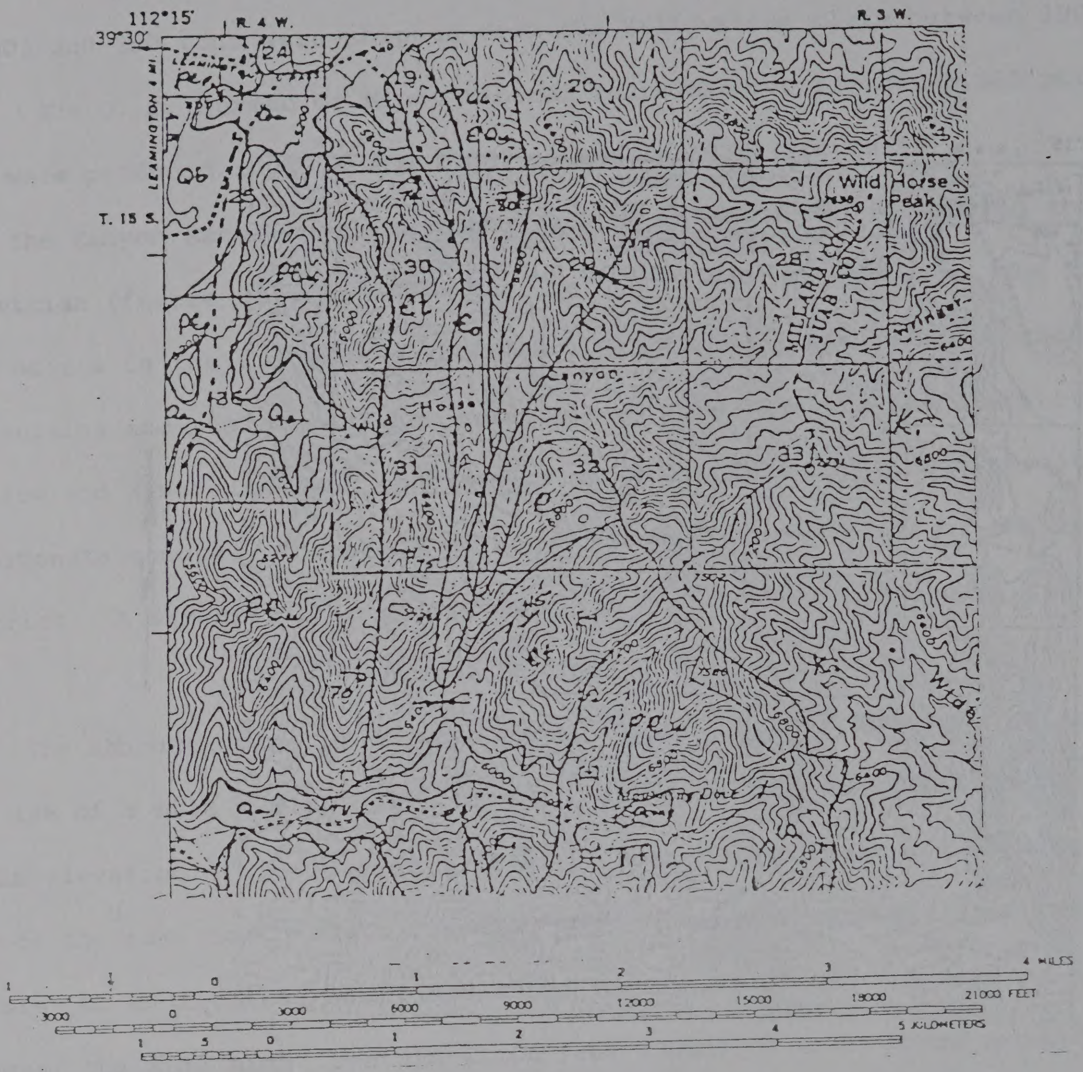
Figure 90:
LOCATION MAP OF THE LEAMINGTON MINING DISTRICT



Adapted from U.S.G.S. Scipio North 15' quadrangle

Figure 91:

GEOLOGIC MAP OF THE LEAMINGTON MINING DISTRICT

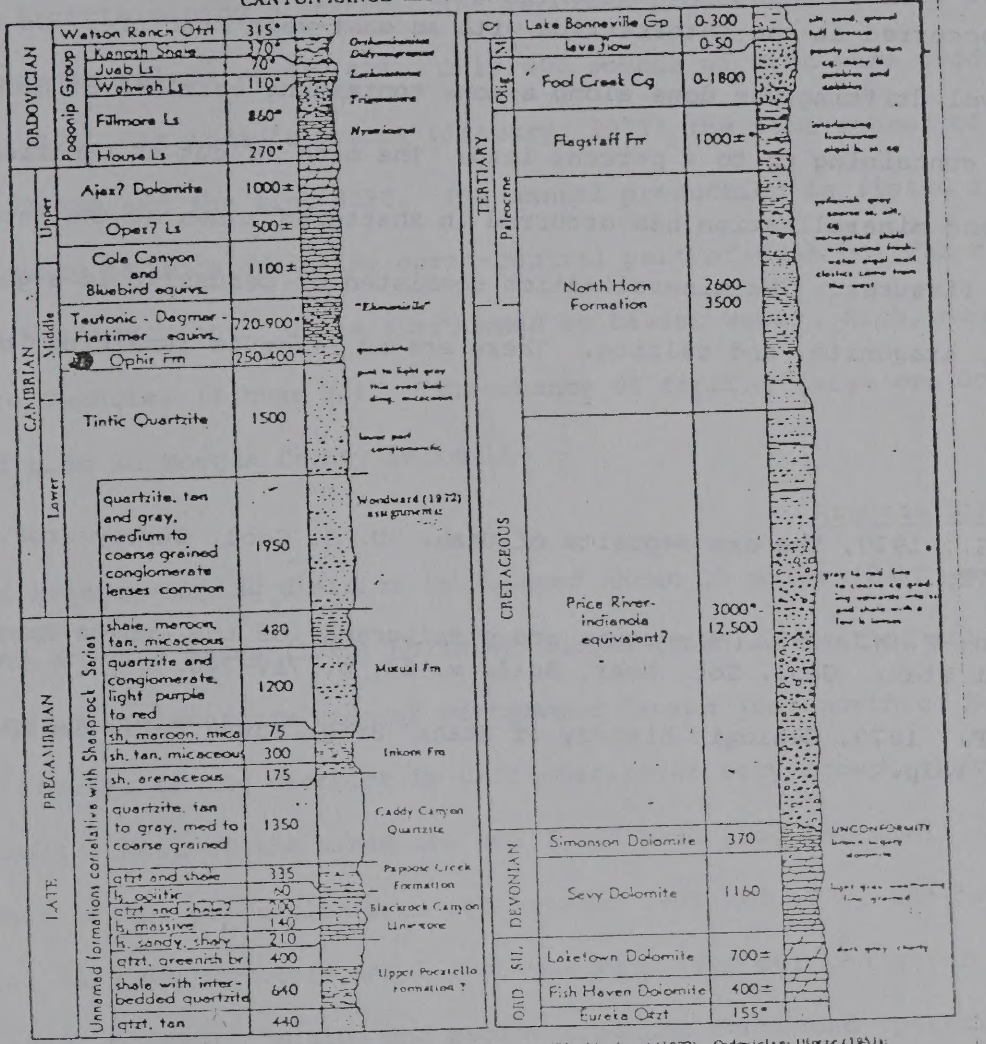


Qa-Alluvial and eolian deposits
Qb-Lake Bonneville deposits
Tf-Fool Creek Conglomerate
Ki-Indianola Group
COu-Cambrian-Ordovicain undifferentiated
Co-Ophir Formation
Ct-Tintic Quartzite
PCp-Prospect Mountain Quartzite
PCu-Precambrian undifferentiated

Geology adapted from F.W.Christiansen,1952
Base map adapted from U.S.G.S. Scipio North 15' quadrangle

Figure 92:
STRATIGRAPHIC COLUMN FOR THE CANYON RANGE

CANYON RANGE and NORTHERN PAVANT RANGE



After Christiansen (1952), Hintze (1972). Precambrian- Crittenden and others (1971); Woodward (1972). Ordovician: Hintze (1951); Webb (1958). Flagstaff-North Horn Fms: Weiss (1969); Quaternary: Varnes and Van Horn (1961)
* thickness figures for northern Pavant Range only.

● Ore-bearing horizon

Adapted from L.F. Hintze, 1973, Geologic History of Utah, p.151

with levels at 50, 100, and 170 feet (15, 30, and 52m). Small bodies of ore were stoped along a north-striking structure on the 50-foot level where shattering occurred at the intersection with an east-west fracture. On the 170-foot level drifting was done along a zone containing veinlets of dolomite and calcite containing up to 4 percent lead. The mine is cut in Cambrian carbonates and mineralization has occurred in shattered zones at the intersections of fissures. The mineralization consisted of cerussite in a gangue of dolomite, aragonite, and calcite. There are no reserves remaining in the mine.

References:

Butler, B. S., 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672p.

Christiansen, F. W., 1952, Structure and stratigraphy of the Canyon Range, central Utah: Geol. Soc. Amer. Bull. v. 63, p. 717-740.

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MORGAN COUNTY

Morgan County has produced a minor amount of lead and zinc, principally from the Argenta mining district. The recorded production of lead stands at 683,383 pounds valued at $45,419. Only 600 pounds of zinc were produced valued at $78. At today's prices (January, 1977) the same amount of lead is worth $183,590 and the zinc $222. The annual production is listed in table 24. Morgan County is located in the north-central part of Utah not far from the populous Wasatch Front. It is surrounded by Davis, Weber, Rich, Summit and Salt Lake Counties (figure 93). The chance of finding large ore bodies of lead and zinc in Morgan County is small.

Argenta District

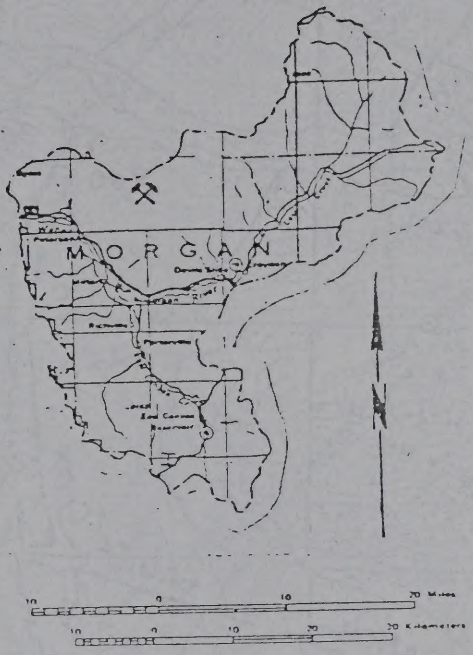
The Argenta mining district is located about 15 miles (24km) east of Ogden and about 8 miles (13km) north of Morgan (town). Most of the district's mines are on the southern side of Cottonwood Canyon just north of Durst Canyon. Access to the district is difficult, over very steep, rocky roads and switchbacks. Most of the mines are small and have produced small amounts of ore. Most of the production occurred between 1905 and 1920, the ore-grade averaging 16.9 percent lead and 2.7 ounces of silver per ton prior to 1918 (Heyl, 1965, p. B44). Mining and prospecting has continued sporadically until recent times.

The rocks in the district range in age from Precambrian to Mississippian (figure 94). The strata consist of limestones, dolomites, sandstones, shales, and quartzites striking north-south and dipping steeply to the east. Faults and thrusts are dominant structures in the district. The Durst thrust lies to the west of the Precambrian units and places the Cambrian Tintic Quartzite over the Precambrian Farmington Canyon Complex. No mineralization seems to be associated with this thrust. The mineralization may be associated with the Spring Branch fault, a normal fault of moderate displacement, several prospects are located just north of this structure. Most district ore deposits are

Table 24: Production of Metals from Morgan County, 1905-1976

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1905	?	35,000	---	1,000	---	900	$2,450
1906	?	40,000	---	2,000	---	301	2,982
1907	?	10,000	---	5,000	---	300	1,695
1908	?	8,140	---	9,681	---	1,000	2,403
1909	?	4,000	---	10,000	---	300	1,616
1910	?	10,000	---	---	---	147	2,206
1911	26	16,890	---	---	0.29	149	845
1912	134	71,730	---	50	---	603	3,607
1913	52	23,994	---	---	0.29	97	1,121
1914	13	1,079	---	---	---	5	45
1915	108	48,501	---	228	---	424	2,535
1916	100	36,834	---	1,031	---	314	3,003
1917	171	75,400	---	---	---	703	7,063
1918	286	104,107	---	---	---	1,220	8,612
1919	59	24,035	---	---	---	223	1,524
1920	15	---	---	2,994	---	130	693
1921-1924				no production			
1925	29	6,622	---	---	---	55	614
1926	260	75,656	---	---	0.39	805	6,564
1927	127	41,803	---	298	0.78	472	2,957
1928-1932				no production			
1933	6	6,992	---	---	---	18	265
1934-1939				no production			
1940	5	4,400	---	---	---	7	225
1941	17	7,300	---	---	---	21	431
1942	1	300	---	---	---	---	20
1943-1950				no production			
1951	17	6,700	---	---	---	53	1,207
1952-1956				no production			
1957	96	10,200	---	700	---	108	1,768
1958	8	6,000	---	---	---	15	716
1959				no production			
1960	40	7,700	600	---		102	1,071
1961-1976				no production			
	1,570 (Incomplete)	683,383	600	32,982	1.75	8,472	58,238

Sources: 1905-1910, 1960: rough estimates
all other years: U. S. Bureau of Mines Mineral Yearbooks



MORGAN COUNTY

1. Argenta District

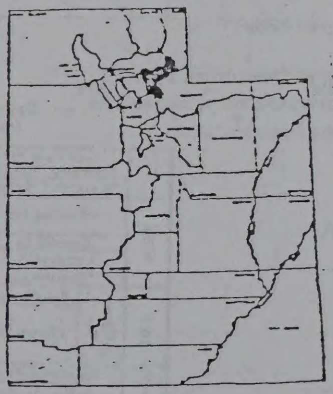
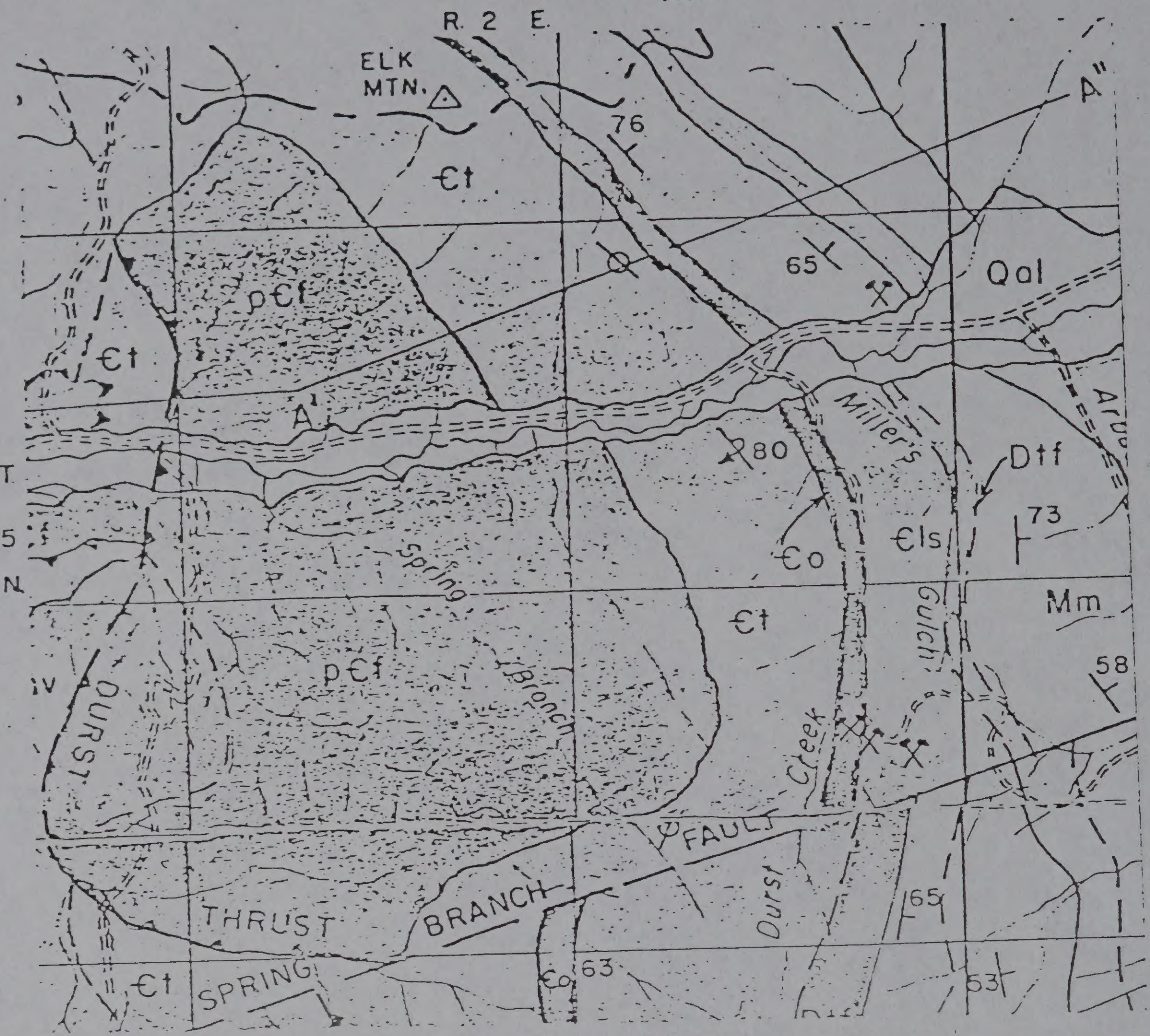


Figure 93: Lead-zinc mining district (Argenta) in Morgan County



EXPLANATION

Quaternary	Qal	Alluvium
Mississippian	Mm	Madison limestone
Devonian	Dtf	Three Forks (?) Formation
Cambrian	Ɛls	Cambrian limestones and dolomites undifferentiated
	Ɛo	Ophir Shale
	Ɛt	Tintic Quartzite
Precambrain	pƐf	Farmington Canyon Complex

Strike and Dip of beds

Strike and Dip of Overturned Beds

Fault

Thrust Fault

Prospects

Scale: 1:31,680

0 1 2 MILES

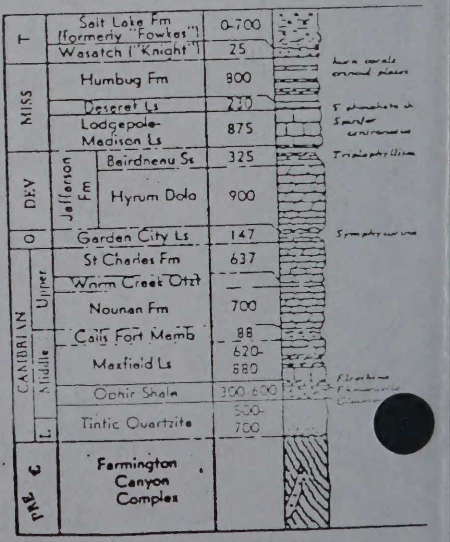
Figure 94b: Geologic map of Argenta district

Ore-bearing horizon

Figure Geologic map of Argenta district

Source: Coody, 1957, plate 1.

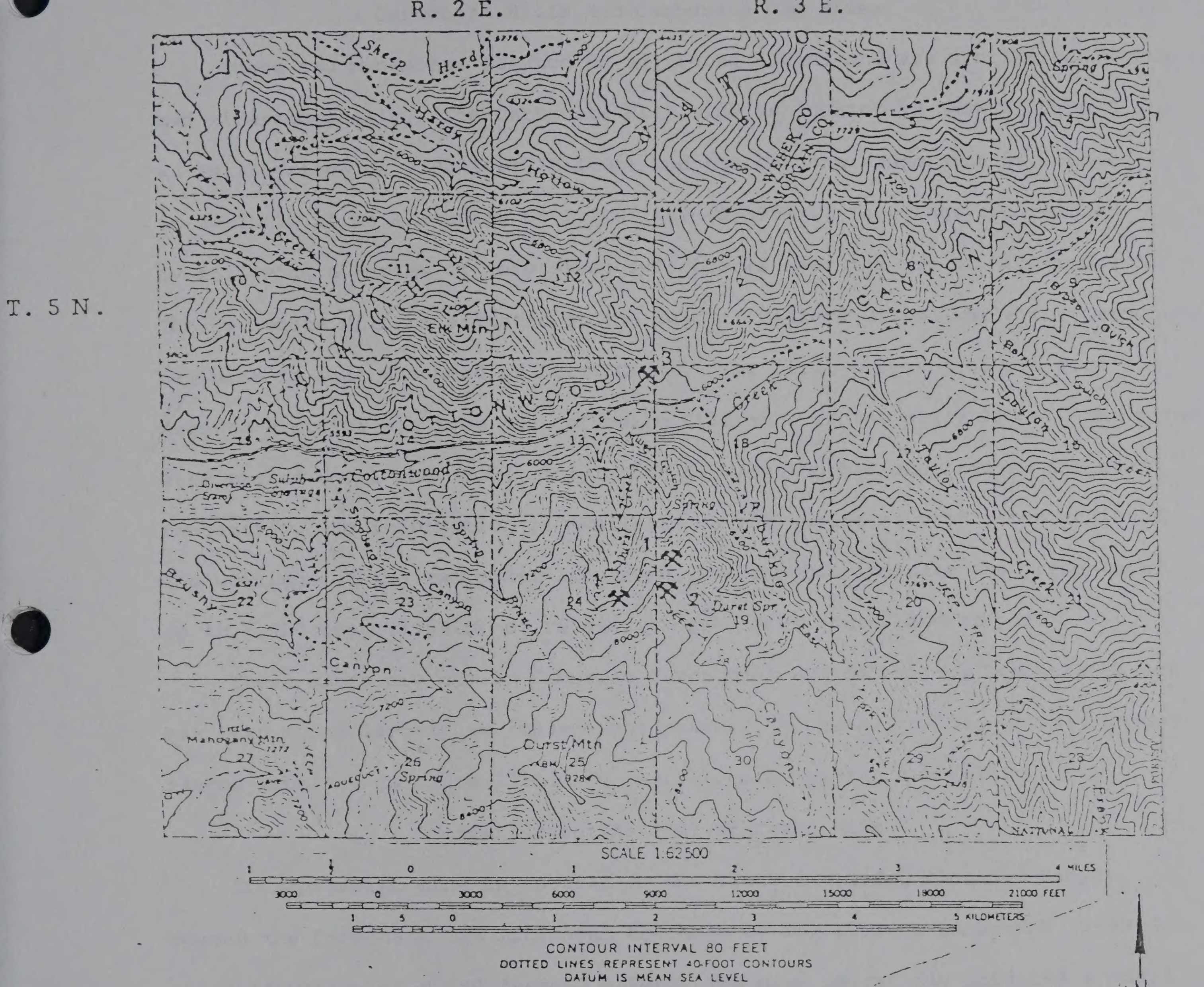
a.- Ogden Canyon (Autochton)



T		Salt Lake Fm (formerly "Fowkes")	0-700
		Wasatch ("Knight")	25
MISS		Humbug Fm	800
		Deseret Ls	230
		Lodgepole-Madison Ls	875
DEV	Jefferson Fm	Beirdneau Ss	325
		Hyrum Dolo	900
O		Garden City Ls	147
CAMBRIAN	Upper	St Charles Fm	637
		Worm Creek Qtzt	—
		Nounan Fm	700
	Middle	Calls Fort Memb	88
		Maxfield Ls	620-680
		Ophir Shale	300-600
	L.	Tintic Quartzite	500-700
PRE Ɛ		Farmington Canyon Complex	

Stratigraphic column adapted from L.F. Hintze, Geologic History of Utah, p. 125

LOCATION MAP OF THE ARGENTA MINING DISTRICT



Argenta district

1. Carbonate Hill and Carbonate Gem
2. Silver Zone
3. Morgan Chief

Figure 94a: Topographic map of Argenta district, Morgan County, Utah

Adapted from U.S.G.S. Morgan 15' quadrangle

replacements of limestone and dolomite. The deposits are generally small, high-grade bodies, but the ore potential for the area is small.

Carbonate Hills and Carbonate Gem Mines

These two mines are located on adjoining claims and are similar geologically and mineralogically. The Carbonate Hill mine is located in SWSWSW 19-5N-3E at an elevation of 7100 feet (2,163m) and the Carbonate Gem mine is located in 24-5N-2E at an elevation of 7,200 feet (2,195m). The mines are reached by following a series of very steep switchbacks near the top of Miller Gulch. The Carbonate Hill is situated at the head of Millers Gulch, while the Carbonate Gem mine is near the head of Durst Creek. The first shipment of ore from the Argenta district was from the Carbonate Hill mine in the early 1900s. The mines were worked until the 1920s, only minor prospecting has occurred in the area thereafter. No information is available on the amount of production achieved. The workings of the two mines are caved, but reports indicate the presence of up to 5,000 feet (1,542m) of raises, winzes, cross-cuts, and stopes.

These mines are cut in Cambrian limestones and dolomites; lead-silver ore has been found largely as replacement bodies. Minerals include galena, cerussite, plumbojarosite, jarosite, limonite, smithsonite, pyrite and calcite.

Morgan Argentine (Silver Zone) Mine

This patented mine is located on the south side of Cottonwood Canyon beyond the Carbonate Gem mine near the head of Durst Creek in SWSWNW 19-5N-3E at an elevation of 8,480 feet (2,585m). The mine reportedly produced a small amount of ore, the extent of the workings is unknown. Lead, silver, and zinc mineralization is in Cambrian limestones and dolomites as small replacement bodies along bedding planes and in fissures (Butler and others, 1920, p. 219). The ore minerals are galena and cerussite in a gangue of barite, calcite, pyrite, and limonite.

Morgan Chief Mine

This is the only mine located north of Cottonwood Canyon in the district, and is directly opposite the mouth of Millers Gulch. The Morgan Chief is in NENENE 13-5N-2E at an elevation of 6,050 feet (1,844m). A high grade vein found adjacent to a cave yielded a small amount of lead-silver sulfide ore. The workings are cut in undifferentiated Cambrian limestones and dolomites, the limestone being replaced. The extent of mineralization is limited and the potential for additional ore is minor.

References:

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Anonymous, 1906, The Carbonate Hill: Salt Lake Mining Rev., April 30, p. 32.

Butler, B. S., and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672p. (p. 218-219)

Coody, G. L., 1957, Geology of the Durst Mountain, Huntsville area, Morgan and Weber Counties, Utah: Univ. of Utah M. S. thesis, 61p.

Heyl, Allen V., 1963, Oxidized zinc deposits of the United States, part 2, Utah: U. S. Geol. Survey Bull. 1135-B, p. B43-44.

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PIUTE COUNTY

Piute County mines have produced significant amounts of lead and zinc; presently the Deer Trail mine is the only producer. These metals have been produced along with gold, silver, copper, mercury, alunite, and uranium. Through 1976 it is estimated that almost 16.6 million pounds of lead and a little more than 16.4 million pounds of zinc have been produced valued at $1,808,636 and $2,399,613 respectively. At today's prices (January,1977) the same amount of lead would be worth about 4.46 million dollars and the zinc, 6.08 million dollars (table 25). Piute County is located in the south-central part of Utah and is surrounded by Sevier, Wayne, Garfield, and Beaver Counties (figure 95). Mount Baldy and Ohio are the mining districts that have produced the lead and zinc and both have much promise for its future production.

Mount Baldy District

The Mount Baldy mining district has its mines on the east slope of the Tushar Mountains, southwest of Marysvale. The district is separated from the Ohio district on the north by a ridge running from Delano Peak to Aetna Peak, then northeasterly along the crest to the valley floor. The district encompasses the Cottonwood Creek drainage, the front of Deer Trail Mountain, and several drainages south of Cottonwood Creek (figure 96). The district has been an important producer of lead-zinc ores since the discovery of the Deer Trail ore body in 1878. The bulk of the district's production has come from the Deer Trail mine from which more than 208 thousand tons have been mined valued in excess of $7,000,000 at the time of production (Callaghan, 1973, p. 46-47).

Rocks exposed in the Mount Baldy mining district range in age from the Permian Kaibab Limestone to the Tertiary Bullion Canyon volcanics. Most of the area is covered by the Tertiary volcanic flows and only the east slopes of

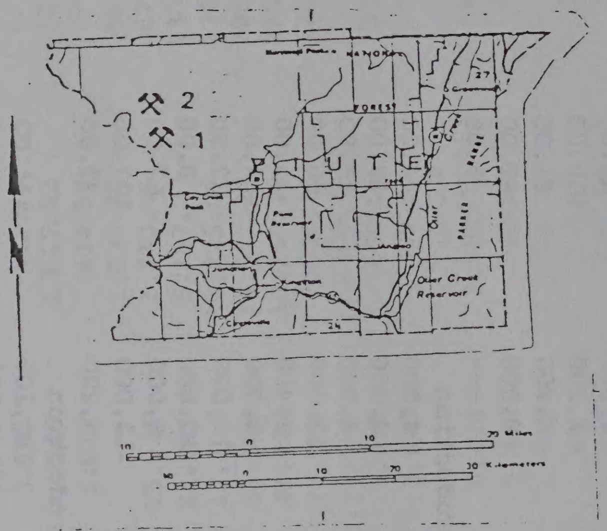
Table 25: Production of metals from Piute County, 1903-1976

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1903	?	---	---	---	22,801.00	83,334	$523,821
1904	?	17,350	---	---	18,454.00	58,787	425,937
1905	?	12,560	---	---	116.00	6,996	7,262
1906	?	200	---	400	3,901.63	3,348	84,265
1907	?	16,148	---	6,839	2,431.63	5,500	56,814
1908	?	7,404	---	94	46.88	3,548	3,173
1909	338	440	---	1,816	162.83	1,345	4,372
1910	2,726	---	---	6,603	333.65	4,713	10,363
1911	3,158	---	---	7,816	1,256.20	5,393	29,803
1912	1,335	21,889	---	3,106	167.28	2,822	6,691
1913	11,809	46,458	---	3,904	2,504.90	9,739	60,312
1914	1,457	119,832	---	3,635	381.49	11,676	19,499
1915	192	3,231	---	1,345	1,617.52	2,775	35,231
1916	326	49,983	---	5,612	434.99	7,188	18,554
1917	2,128	540,476	---	---	1,039.72	46,740	111,612
1918	3,043	317,286	---	15,921	1,740.49	67,319	129,757
1919	16,509	440,391	---	21,841	5,167.37	130,879	280,806
1920	24,964	859,753	---	12,283	10,225.09	234,818	539,397
1921	35,621	1,597,626	---	30,668	14,539.25	286,473	662,825
1922	38,382	1,622,984	---	49,438	18,250.20	290,354	763,557
1923	16,909	785,411	---	23,524	7,866.89	122,763	321,726
1924	146	2,613	---	2,091	367.41	809	8,620
1925	641	47,831	---	1,932	650.08	13,980	27,575
1926	594	55,528	---	3,640	399.97	6,082	17,015
1927	35	4,920	---	31	12.24	229	679
1928	6,475	19,723	---	8,494	3,885.38	9,443	88,183
1929	2,552	19,667	---	5,443	939.41	7,955	25,815
1930	13	---	---	---	116.39	579	2,629
1931	441	13,645	825	1,697	303.80	2,451	7,682
1932	799	5,282	---	933	630.86	5,337	14,763
1933	761	5,189	---	685	321.65	1,326	7,349
1934	11,331	12,216	---	2,825	3,154.08	15,255	120,855
1935	16,669	35,475	---	2,615	4,276.60	24,939	169,657
1936	18,927	25,261	---	8,000	4,701.80	20,949	182,686
1937	23,095	26,085	---	10,372	4,277.00	31,788	177,077
1938	9,359	23,978	---	5,714	1,497.00	19,933	66,944
1939	2,608	12,766	---	5,269	1,824.00	19,464	78,200
1940	4,240	12,300	---	5,000	1,941.00	13,109	40,007

Table 25 continued:

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1941	2,121	23,000	---	900	929.00	8,543	$40,007
1942	964	58,300	6,000	2,200	291.00	10,066	22,073
1943	1,183	77,000	42,500	4,000	184.00	8,370	23,277
1944	508	33,600	9,500	2,000	265.00	4,486	16,506
1945				no production			
1946	73	600	---	1,000	42.00	562	2,151
1947	746	17,000	---	2,200	139.00	2,484	10,023
1948	495	33,500	200	4,800	81.00	7,277	16,487
1949	1,281	51,000	---	8,000	182.00	17,367	31,722
1950	1	---	---	---	5.00	---	175
1951				no production			
1952	302	26,000	6,000	4,000	74.00	7,372	15,412
1953	511	16,000	10,000	4,000	19.00	2,496	7,318
1954	74	4,000	---	4,000	28.00	4,409	6,698
1955	742	14,000	---	12,000	96.00	12,958	21,650
1956	174	2,000	600	2,400	25.00	2,217	4,297
1957	756	17,400	800	6,700	184.00	13,854	23,577
1958	460	14,000	---	16,000	92.00	6,800	15,159
1959	114	760	10,000	10,000	8.00	8,391	12,207
1960	376	32,000	66,000	8,000	62.00	3,871	18,857
1961	2,197	122,000	476,000	12,000	407.00	16,322	100,636
1962	1,209	97,800	113,800	5,200	72.00	9,065	36,041
1963				no production			
1964	6,987	557,900	1,009,400	10,100	545.00	33,764	137,278
1965	9,086	763,100	1,658,700	6,700	1,190.00	47,617	466,805
1966	10,428	945,500	2,045,900	21,100	886.00	58,067	553,289
1967	4,193	573,400	1,000,300	12,200	522.00	36,032	297,532
1968	4,836	600,700	997,800	29,700	287.00	57,932	362,005
1969	10,619	1,708,900	2,811,700	86,400	637.00	159,304	1,017,821
1970	10,150	1,863,500	2,890,800	---	362.00	165,676	1,040,057
1971	9,873	1,797,064	2,706,973	---	529.00	114,518	1,000,020
1972-1975				no production			
1976	2,000	367,191	569,616	16,273	71.00	32,646	473,415
	340,042	16,599,116	16,433,414	550,559	160,951.68	2,432,604	$10,901,008

Sources: 1903-1910, 1962-1971, 1976 -- Rough estimate
All other years -- U. S. Bur. Mines Mineral Yearbooks.



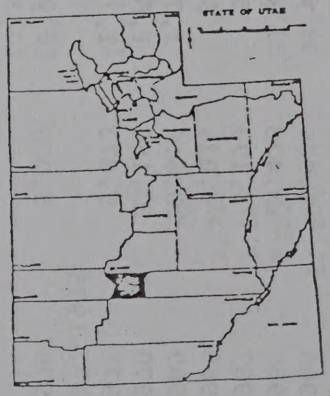
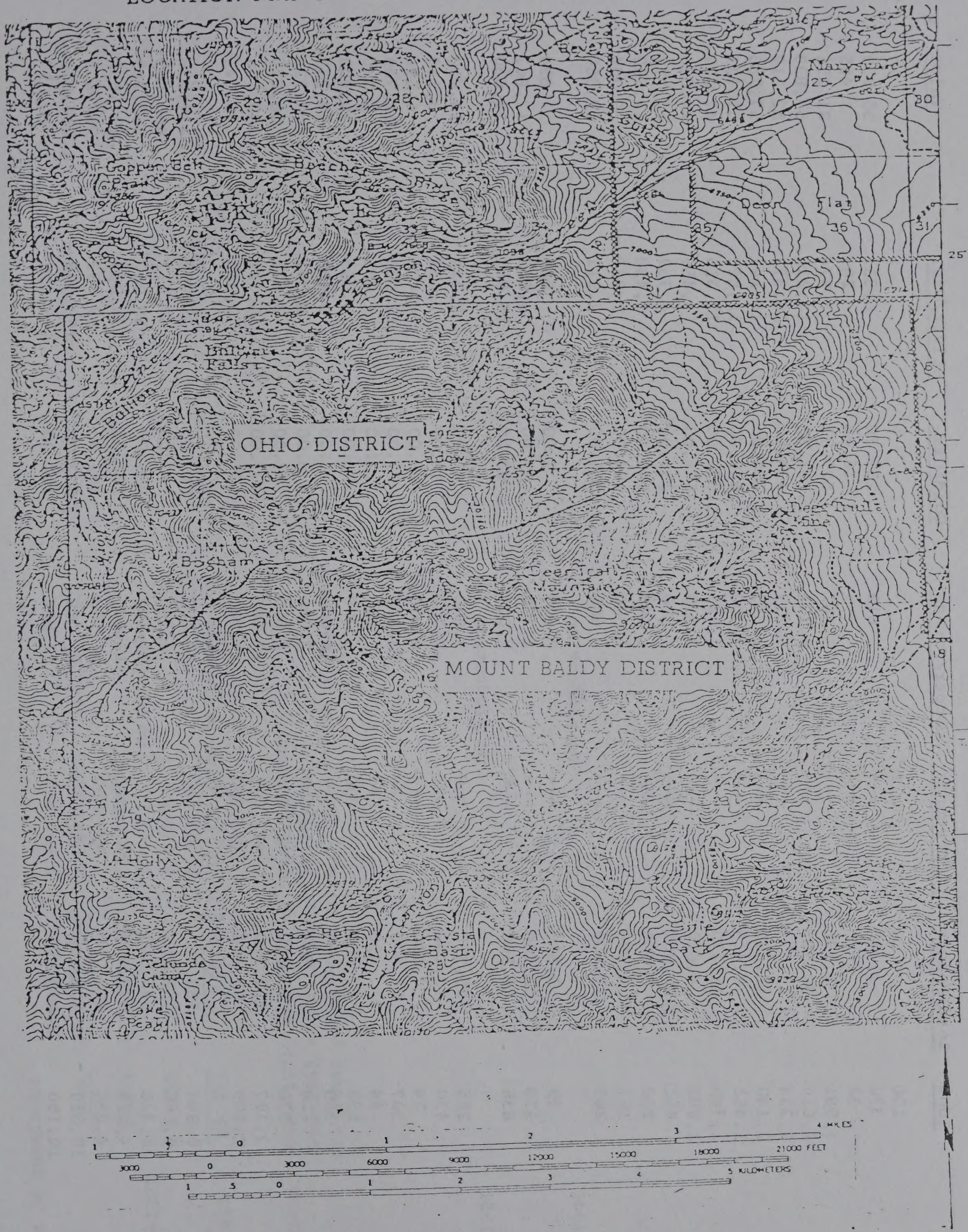


Figure 95: Lead and Zinc districts of Piute County

Figure 96:

LOCATION MAP OF MOUNT BALDY AND OHIO MINING DISTRICTS



Adapted from U.S.G.S. Delano Peak 15' quadrangle

Table 26: Production of metals from the Mount Baldy mining district, 1931-1976

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1931	100	?	?	?	?	?	?
1932	370	1,130	---	819	208.76	6,331	$5,930
1933	32	---	---	---	16.88	283	455
1934	1,081	1,595	---	1,362	529.73	3,974	21,251
1935	2,616	30,325	---	6,121	1,331.80	13,216	57,833
1936	2,234	19,674	---	5,217	1,234.00	10,377	52,612
1937	2,140	15,695	---	6,843	1,200.00	18,141	57,786
1938	1,451	9,413	---	3,000	649.00	12,822	31,731
1939	1,749	11,170	---	3,625	1,079.00	12,316	47,027
1940	1,082	4,800	---	2,310	584.00	5,469	24,830
1941	451	20,000	---	800	257.00	4,739	13,599
1942	288	5,600	---	400	242.00	5,438	12,760
1943	161	2,000	---	1,000	124.00	2,368	6,304
1944	267	17,800	---	600	251.00	2,911	12,360
1945-1946				no production			
1947	39	3,500	---	300	2.00	284	894
1948	378	22,100	---	4,300	57.00	6,582	12,841
1949	836	46,500	---	7,000	93.00	15,081	25,630
1950-1951				no production			
1952	295	25,900	6,000	3,600	41.00	7,224	14,010
1953	430	13,000	7,000	2,000	16.00	1,632	5,119
1954	74	4,000	---	4,000	28.00	4,409	6,698
1955	397	14,000	---	10,600	79.00	11,009	18,769
1956	44	400	600	200	13.00	1,055	1,740
1957	539	17,400	800	5,700	108.00	13,063	19,900
1958	350	12,000	---	14,000	75.00	5,000	12,255
1959	114	767	10,000	2,000	8.00	8,391	9,728
1960	376	15,000	66,700	8,800	62.00	3,871	18,875
1961	2,197	122,300	477,600	12,600	407.00	16,322	100,636
1962	1,209	97,800	113,800	5,200	72.00	9,065	36,041
1963				no production			
1964	6,987	557,900	1,009,400	10,100	545.00	33,764	137,278
1965	9,066	763,100	1,658,700	6,700	1,190.00	47,617	466,805
1966	10,428	945,500	2,045,900	21,100	886.00	58,067	553,289
1967	4,193	573,400	1,000,300	12,200	522.00	36,032	297,532
1968	4,836	600,700	997,800	29,700	287.00	57,932	362,005
1969	10,619	1,708,900	2,811,700	86,400	637.00	159,304	1,017,821
1970	10,150	1,863,500	2,890,800	82,584	362.00	165,676	1,040,057

Table 26 continued

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1971	9,873	1,812,643	2,811,908	80,330	352.00	161,155	$1,000,020
1972-1975				no production			
1976	2,000	367,191	569,616	16,273	71.00	32,646	473,415
Totals	89,452	9,650,001	16,478,624	445,184	13,718.09	953,066	$5,975,836

Sources: 1958, 1971, and 1976 -- rough estimate
1960-1965 -- Callaghan, 1973, p. 47
All other years -- U. S. Bur. Mines Mineral Yearbooks

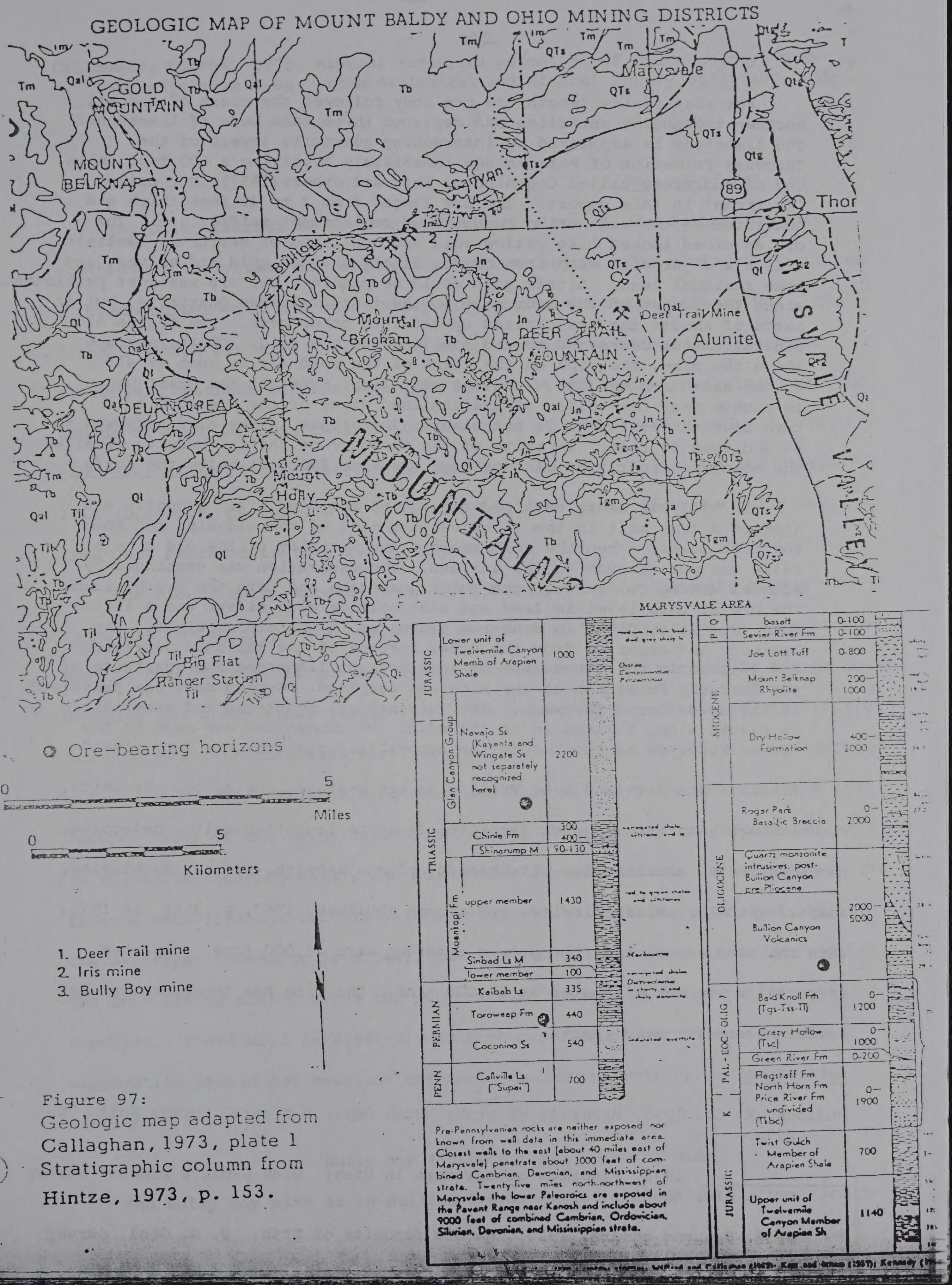
Deer Trail Mountain are the sedimentary rocks exposed (figure 97). The sedimentary units are folded, forming anticlines and synclines. Northeast-trending faults, that allowed the passage of ore-bearing solutions, cut the folds. Lead-zinc replacement ore deposits have formed along the crest of a north-plunging anticline in selective beds in the Toroweap Formation. The near-surface parts of ore-bodies are oxidized, but sulfide mineralization occurs at greater depths. The districts reserves are unknown, but they may be very large. Exploration has not been carried out far ahead of actual mining.

Deer Trail Mine

The Deer Trail mine is on the east slope of Deer Trail Mountain about 6 miles (9.6km) south of Marysvale. The portal of the mine is in SENENE 11-28S-4W at an elevation of 7,400 feet (2,256m). The property is patented and owned by the Deer Trail Development Corporation of Salt Lake City, Utah. Through 1917 the mine was worked intermittently producing ore valued at $150,000 (Butler and others, 1920, p. 556). From 1918 to 1923 the mine produced 138,423 tons of ore which yielded a net smelter return of $2,164,662.57 (Callaghan, 1973, p. 46). Various lessees have operated the mine intermittently since 1923. Arundel Mining Company operated the mine in the 1960s and through 1971 produced 69,934 tons valued at $4,030,339. The mine was closed in 1971 when custom smelters and mills in Utah were closed (Midvale and Tooele). The mine was reopened in 1976 and ore shipped to the Idarado mill in Telluride, Colorado.

The geology and ore deposits of the Deer Trail mine have been summarized by Callaghan (1973, p. 45-46):

> "The ore body, which has been explored and mined at intervals since its discovery in 1878, is remarkable in its configuration. The stopes form an almost continuous ribbon for the full length of the mine--some 4,000 feet. The width is mostly 100 feet or less, but in some places expands to 200 feet and in one area to 400 feet. For the first 2,400 feet the stopes are wide, but they narrow to less than 50 feet in the final 800 feet; they were reached by an incline or winze below the haulage level with levels extending to the ore. Flats and rolls in the footwall surface necessitated driving the haulage level in quartzite well below the ore. The overall trend of the axis in the workings is N. 45° W., but locally the trend is in a series of "dog legs" extending for as much as 1,000 feet N. 70° W. and 400 to 700 feet N. 8° W.



Pre-Pennsylvanian rocks are neither exposed nor known from well data in this immediate area. Closest wells to the east (about 40 miles east of Marysvale) penetrate about 3000 feet of combined Cambrian, Devonian, and Mississippian strata. Twenty-five miles north-northwest of Marysvale the lower Paleozoics are exposed in the Pavant Range near Kanosh and include about 9000 feet of combined Cambrian, Ordovician, Silurian, Devonian, and Mississippian strata.

Figure 97:
Geologic map adapted from Callaghan, 1973, plate 1
Stratigraphic column from Hintze, 1973, p. 153.

For most of its length the ore body followed the crest of a small northwest-plunging anticline and replaced three thin beds of limestone. The limestone is separated by intervening quartzite layers of the Toroweap Formation of Permian age immediately overlying a 500-foot thick bed of quartzite called Coconino by Kerr and others (1957), but called 'Talisman' in this report. The ore ranged from 2 to 40 feet thick and consisted of the weathering products of replacement sulfide ore. The ore as mined looked like yellow soil and consisted of sericite, kaolinite, silica and jarosite with iron oxide, finely divided gold and silver, and some residual lead. Little gold could be panned. The ore was most persistent along the lowest of the beds next to the thick Talisman Quartzite, but in parts of shoots the ore crossed upward into other beds. The degree of mineralization decreased toward the limbs of the fold. On the surface above the mine, the dips on the limbs of the fold are as much as 45° E. on the east limb and 25° W. on the west limb. Whether the crest began to plunge near the collar of the inclined winze or the ore zone to turn down the west limb is not clear. The stopes in the area narrowed to 40 and even 20 feet. In spite of the tendency of the ore body to parallel the mountain front, the old workings are some 800 feet below the surface.

In 1945 Pat Henry obtained control of the Deer Trail property and started a long adit in the alluvium southeast of the old mine and some 600 feet lower. When the adit reached the vicinity of the old mine a raise was put through to the surface. The excavation was continued by Arundel Mining Co. through the thick quartzite and into the ore horizon. The ore at this level is lead and zinc sulfide with silver and a little gold, but is confined in a narrow ribbon as in the old workings. The ore body had departed from the upper surface of the Talisman Quartzite and climbed in the succession of thin beds of limestone and quartzite of the Toroweap Formation as the mine was deepened. Gypsum beds are preserved in the unweathered Toroweap. The Talisman was shattered and mineralized in places along the course of the adit. No connection was made to the old workings so as to exclude the accumulated gas from the deep mine."

Minerals found in the Deer Trail mine are anatase, anglesite, cerussite, fluorite, galena, native gold, jarosite, limonite leuchtenbergite, malachite, manganocalcite, octahedrite, pitchblende, plumbojarosite, pyrite, pyrolusite, quartz, specularite, sphalerite, and zircon (Bullock, 1967, p. 46). In 1971, when the mine was closed, the proven reserves were 16,000 tons. Unproven speculative ore was estimated at 64,000 tons. The mine has the potential for producing ore for many years.

References:

Bullock, K. C., 1967, Minerals of Utah: Utah Geol. & Mineral Survey Bull. 76, 237p.

______________, 1976, Fluorite occurrences in Utah: Utah Geol. & Mineral Survey Bull. 110, 89p.

Butler, B. S., and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672p.

Callaghan, Eugene, 1973, Mineral resources potential of Piute County, Utah and adjoining area: Utah Geological and Mineral Survey Bull. 102, 135p.

Ohio District

. The Ohio district is located on the east slope of the Tushar Mountains southwest of Marysvale and straddling Bullion Canyon. The mining district has a common border with the Mount Baldy district to the south (figure 96). The first location was made in 1868 and an unknown amount of metals have been produced. District records were kept after 1931 and since then almost 260,000 pounds of lead and more than 62,000 pounds of zinc have been produced. The important mines of the district include the Bully Boy (Bully Boy and Webster), Iris (Deseret), Cascade, Glen Erie, and Great Western. Only the Bully Boy and Iris were examined in this study. (Table 27)

The oldest unit exposed in the Ohio district is the Jurassic Navajo Sandstone, which crops out in Bullion Canyon near the Iris mine as a quartzite. Most of the district is covered by Tertiary volcanics consisting of latite tuffs, breccias and other flows (figure 97). The principal structures of the district are northwest- to northeast-striking faults that dip to the east, downdropping successive blocks. Mineralizing solutions have formed veins of ore along the faults. Some of the veins have formed in the Navajo Sandstone (footwall) adjacent to volcanics (hanging wall), and others have formed entirely in volcanics. The fissure vein-fillings contain values of silver, gold, lead, zinc, and copper. The principal commodity is silver, the other metals are present as by-products. The Ohio mining district has the potential of containing large replacement deposits. These will be difficult to find considering the volcanic cover. Exploration should not overlook the deeper sediments underlying the Navajo Sandstone.

Bully Boy (Bully Boy and Webster) Mine

The Bully Boy mine is in Bullion Canyon about seven miles (11.2km) south-

Table 27: Production of metals from the Ohio mining district, Piute County, Utah, 1931-1976

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1931	259	13,587	835	1,697	45.76	1,950	$2,399
1932	53	4,152	---	114	38.68	318	1,188
1933	104	5,189	---	685	159.08	903	4,529
1934	303	10,621	---	2,463	193.08	3,188	9,399
1935	232	5,150	---	1,494	153.00	1,522	6,779
1936	226	5,587	---	2,783	98.40	1,583	5,183
1937	437	10,390	---	3,529	254.00	5,404	14,110
1938	261	14,565	---	2,714	87.00	3,465	6,221
1939	172	1,596	---	1,644	70.00	959	3,347
1940	246	7,500	---	2,690	66.00	1,679	4,183
1941	47	3,000	---	100	5.00	346	604
1942	676	52,700	6,000	1,800	49.00	4,628	9,313
1943	1,022	75,000	42,500	3,000	60.00	6,002	16,973
1944	241	15,800	9,500	1,400	14.00	1,575	4,146
1945				no production			
1946	33	600	---	1,000	29.00	526	1,667
1947	387	13,500	---	1,600	43.00	1,947	5,547
1948	117	11,400	200	500	24.00	695	3,646
1949	445	4,500	---	1,000	89.00	2,286	6,092
1950	1	---	---	---	5.00	---	175
1951				no production			
1952	6	100	---	400	---	126	227
1953	81	3,000	3,000	2,000	3.00	864	2,199
1954				no production			
1955	345	---	---	1,400	17.00	1,764	2,881
1956	130	1,600	---	2,200	12.00	1,051	2,557
1957	131	---	---	900	5.00	592	982
1958	?	?	?	?	?	?	?
1959-1976				no production			
Totals:	5,955	259,537	62,035	57,113	1,380.00	43,373	$114,347

Source: U. S. Bur. Mines Mineral Yearbooks west of Marysvale in NENENW 5-28S-4W at an elevation of 7,900 feet (2,408m). The mine is one of the earlier workings of the district and the most extensively worked in Bullion Canyon. Mine workings consist of several levels containing about 6,000 feet (1,289m) of drifts, crosscuts, raises, winzes, and stopes, of which 3,200 feet (975m) are on the lowest level. The vertical distance between the lowermost and uppermost levels is 600 feet (183m). The underground workings are presently caved at the portals and are not accessible (figure 98).

Mineralization is found in northeast striking veins along which the main workings have been driven. Crosscuts to the east have encountered northwesterly striking veins. The main production from the mine has been from northeast-striking veins. Mineralization has been followed for 1/2 mile (805m) underground and can be traced on the surface for a full mile (1.6km). Minerals found in the mine are galena, chalcopyrite, sphalerite, anglesite, cerussite, covellite, chalcocite, chrysocolla, malachite, azurite, wulfenite, native gold, gold and silver tellurides, tetrahedrite, quartz, calcite, fluorite, and barite. There are no reserves remaining in the mine. Replacement ore bodies may be found in sedimentary units which underlie the Navajo Sandstone.

Iris (Deseret)Mine

The Iris or Deseret mine is in Bullion Canyon about 7 miles (11.2km) southwest of Marysvale. The mine is 600 feet (183m) east of the portal of the Bully Boy lower level. The Iris portal is in NENENE 5-28S-4W and at elevation of 7,850 feet (2,393m). Several hundred tons of ore were shipped from the mine; the workings consist of a main adit containing about 800 feet of drifting (244m) that follows the vein. Stoping has taken place above the drift in several places. Two higher adits are on the property, one 80 feet (24m) and another 140 feet (43m) higher than the lower portal. These adits were caved (1976) at the portals.

Mineralization is along a northeast-striking vein along which the adits have been driven. Minerals contained in the ore are sphalerite, galena,

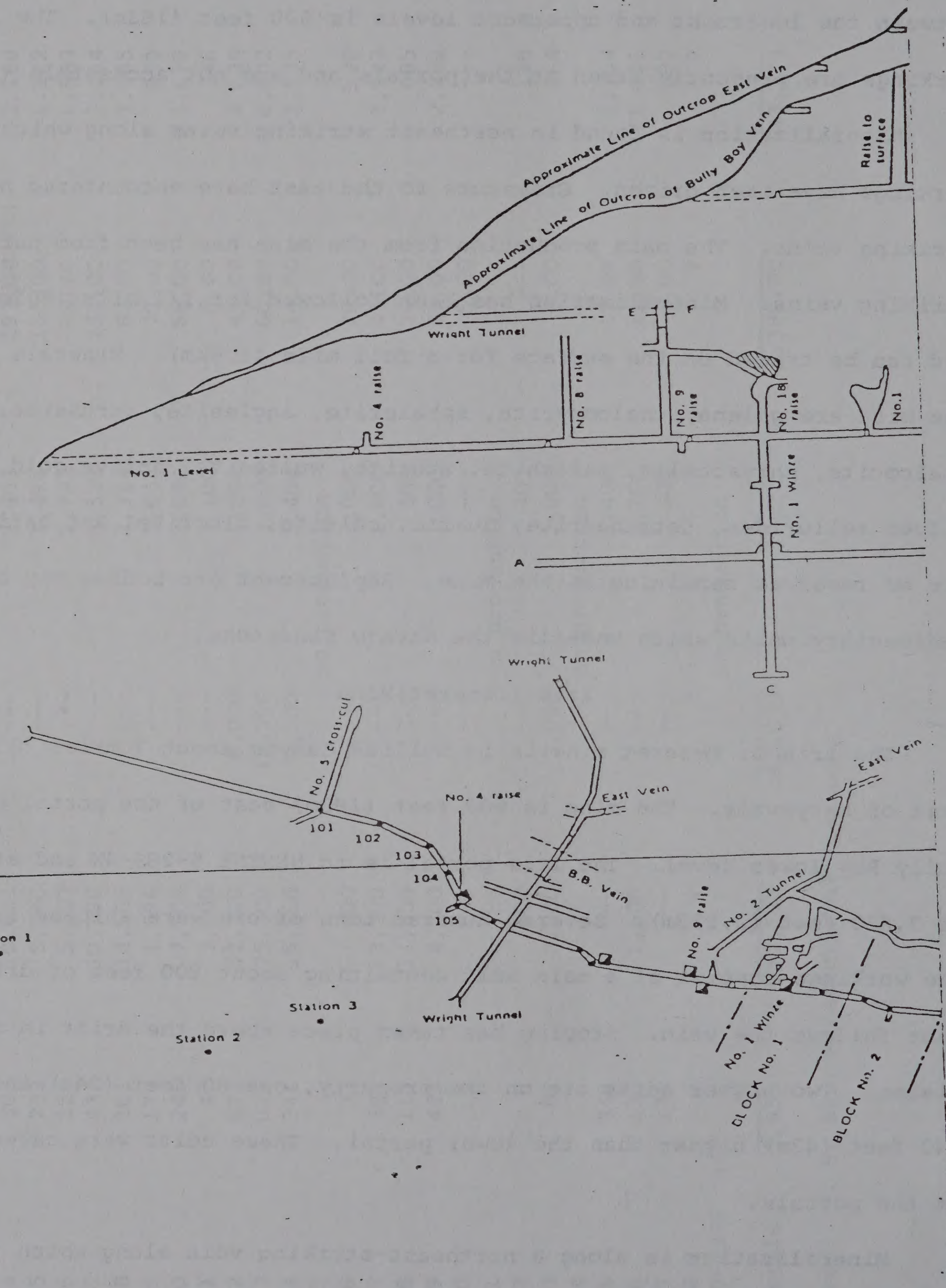
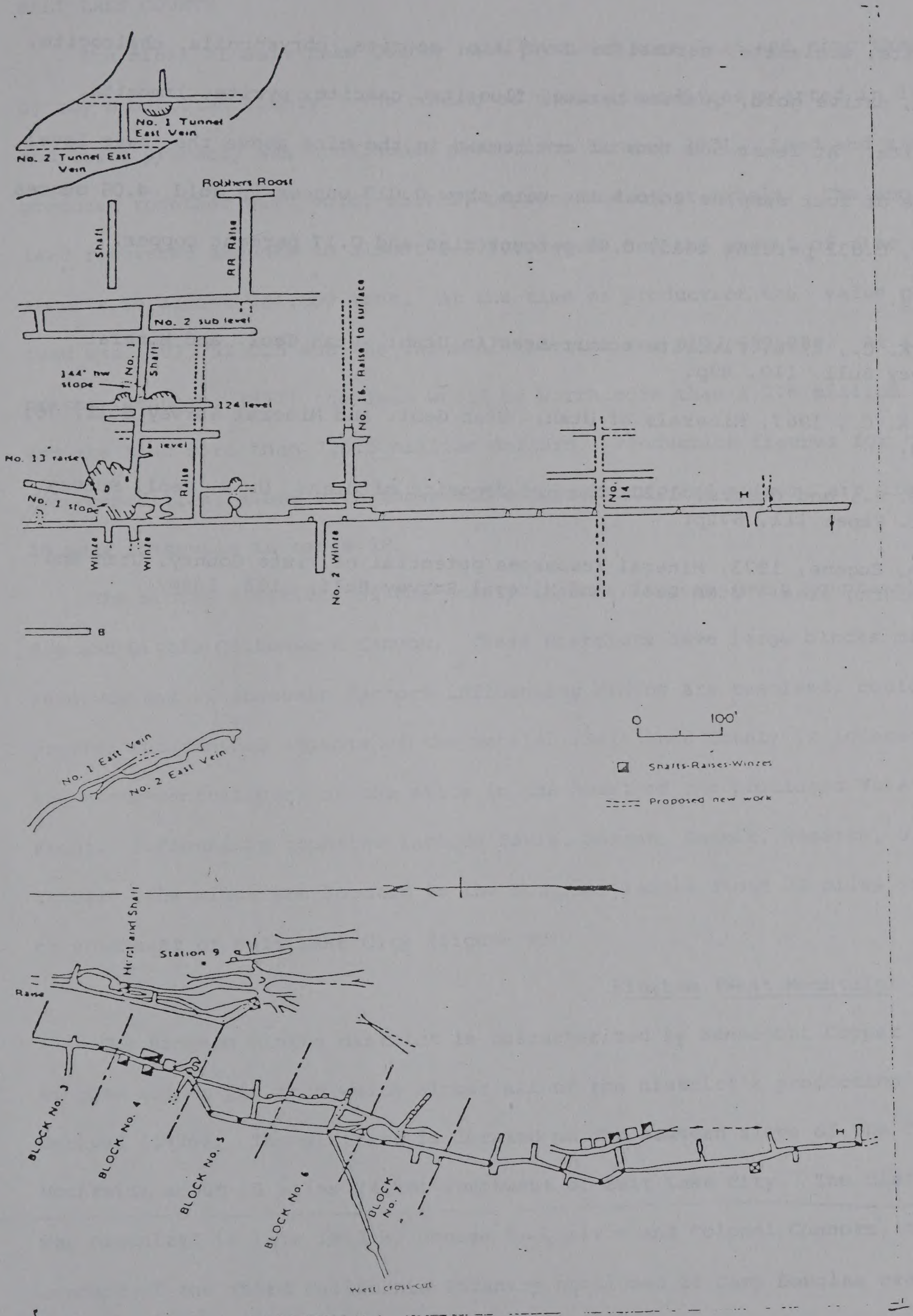


Figure 98
Plan and longitudual section of Bully Boy mine after Callaghan, 1973



Plan and longitudal section of Bully Boy mine after Callaghan, 1973 chalcopyrite, anglesite, cerussite, covellite, azurite, chrysocolla, chalcocite, wulfenite, native gold, quartz, barite, fluorite, calcite, pyrite, limonite, and hematite. At least 500 tons of ore remain in the mine above the lower level. An average of four samples across the vein show 0.013 ounces in gold, 4.06 ounces in silver, 0.031 percent lead, 0.06 percent zinc and 0.17 percent copper.

References:

Bullock, K. C., 1976, Fluorite occurrences in Utah: Utah Geol. and Mineral Survey Bull. 110, 89p.

Bullock, K. C., 1967, Minerals of Utah: Utah Geol. and Mineral Survey Bull. 76, 237p.

Butler, B. S., and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672p.

Callaghan, Eugene, 1973, Mineral resources potential of Piute County, Utah and adjoining area: Utah Geol. and Mineral Survey Bull. 102, 135p.

SALT LAKE COUNTY

The mines of Salt Lake County have produced more lead and zinc than those of any other Utah county. The mining of these commodities started in 1863 and there probably was continuous production through 1971. Lead and zinc were produced together with gold, silver, copper, and other metals. The amount of lead recovered amounts to almost 2,375,000 tons and the amount of zinc recovered amounts to almost 981,800 tons. At the time of production the value of the lead was $383,752,025 and the value of the zinc was $193,689,228. At today's prices (January, 1977) the lead would be worth more than 1,276 million dollars and the zinc more than 726.5 million dollars. Production figures for these two commodities, along with those for copper, gold, and silver, are listed in 10 year intervals in table 28.

The mining districts of the county include Bingham (West Mountain) and Big and Little Cottonwood Canyon. These districts have large blocks of known reserves and if economic factors influencing mining are resolved, could again provide substantial amounts of the metals. Salt Lake County is located in the north-central part of the state in the heart of the populated Wasatch Front. Surrounding counties include Davis, Morgan, Summit, Wasatch, Utah, and Tooele. The mines are located in the mountain ranges about 20 miles southwest or southeast of Salt Lake City (figure 99).

Bingham (West Mountain) District

The Bingham mining district is characterized by Kennecott Copper Corporation's Bingham copper pit from which almost all of the district's production is currently derived (1976). The district is located on the eastern slope of the Oquirrh Mountains about 25 miles (40km) southwest of Salt Lake City. The district was was organized in late 1863 by George B. Ogilvie and Colonel Connors, then in command of the Third California Infantry stationed at Camp Douglas near Salt Lake City. Claims were placed over a large area, but little production was realized until 1870 due to the lack of equipment and the high cost of acquiring

Table 28: Production of metals from Salt Lake County, Utah, 1865-1880

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1865-1880	*139,369	226,077,502	---	2,158,900	72,673.01	11,902,235	$29,273,375
1881-1890	* 47,302	172,270,600	---	2,155,780	47,944.90	7,247,202	16,371,440
1891-1900	*115,017	148,959,863	---	16,726,571	92,826.38	5,964,195	14,321,094
1901-1910	*17,306,755	168,614,303	4,221,889	485,000,097	585,778.27	15,449,320	99,483,923
1911-1920	92,334,287	728,376,513	53,594,253	1,604,774,514	960,152.40	28,006,233	408,691,350
1921-1930	119,020,572	839,093,418	278,909,413	2,075,985,102	1,073,616.61	31,454,527	414,940,720
1931-1940	125,017,183	729,792,678	415,728,531	2,152,747,849	1,394,022.48	34,174,185	337,248,712
1941-1950	275,646,813	591,443,800	380,589,500	4,946,341,100	3,081,252.00	45,054,081	1,044,670,782
1951-1960	283,369,331	607,499,400	474,851,300	4,597,154,900	3,702,300.00	43,532,030	1,714,947,761
1961-1970	304,904,895	502,990,000	336,230,000	4,636,170,000	3,133,061.00	35,126,198	2,086,217,239
1971	35,332,522	34,700,000	19,474,000	512,306,000	309,264.00	3,351,625	292,261,594
1972	35,152,081	---	---	502,880,896	314,101.00	2,661,453	280,365,886
1973	34,000,000	---	---	486,582,000	304,115.00	2,574,000	335,135,400
1974	33,250,000	---	---	475,794,000	297,370.00	2,517,000	466,878,560
1975	28,080,000	---	---	401,702,000	251,065.00	2,125,000	296,537,980
1976	29,410,000	?	?	420,714,000	262,945.00	2,226,000	310,863,073
Totals	1,414,716,127[1]	4,749,818,077	1,963,598,886	23,319,193,709	15,882,487.05	273,365,284	$8,148,208,889

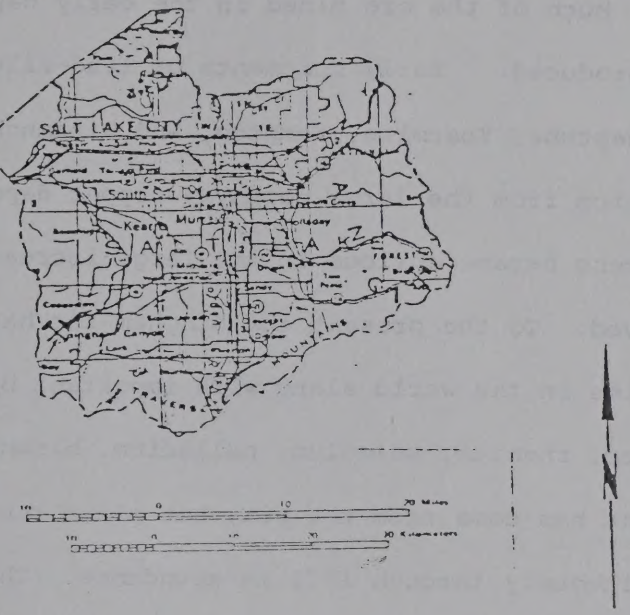
[1] **Includes** an estimated tonnage for the incomplete figures for 1865 to 1910

***Only** recorded tonnages listed.

1973-1976: All figures are rough estimates, some lead and zinc may have been produced in 1976

1865-1917: Butler, 1920

All other years: U. S. Bur. Mines Mineral Yearbooks



SALT LAKE COUNTY

1. Big & Little Cottonwood District

2. Bingham District

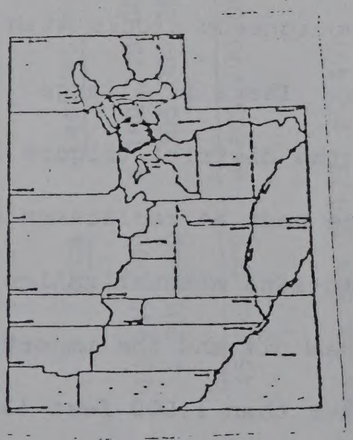


Figure 99: Lead-zinc mining districts of Salt Lake County

it. The completion of the transcontinental railroad at Promontory, Utah, made the development of the district much easier, providing not only a way to obtain mining equipment, but in allowing a cheaper access to eastern markets. In 1873 a railroad line was completed into Bingham Canyon and mining was pursued with much vigor. Much of the ore mined in the early days was lead-silver; placer gold was produced. Early shipments of lead-silver ore came from the Jordan, Galena, Neptune, Yosemite, Kempton, and Winamuck mines (Hammond, 1961, p. 122). Production from the large porphyry copper deposit did not start until 1904 and its success became obvious in the large increase in production in the years that followed. To the present the Bingham pit has produced more copper than any other mine in the world along with important by-products, such as gold, molybdenum, silver, rhenium, selenium, palladium, bismuth and tellurium. Not much lead and zinc has come from the pit, but mines round-about produced the commodities continuously through 1971 in abundance. The production of metals from the non-porphyry areas of the district through 1972 are tabulated on table 29.

The geology of the district is characterized by Pennsylvanian sedimentary rocks dipping steeply to the north and intruded by two igneous stocks with accompanying dikes and sills surrounding their borders. There is a large amount of faulting, fissuring, and brecciation within the district (figure 100). Most lead-zinc-silver ore is found within the limestone beds as replacements and vein fillings along fissure systems (figure 101). Lead-zinc mineralization follows a somewhat circular zone surrounding the Bingham pit and the important copper mineralization. The inner limit is rarely closer than 1,000 feet (305m) to the copper zone and the outer limit is rarely more distant than 10,000 feet (3,050m). The mined lead-zinc-silver mined from this circular zone has averaged about 7 percent lead, 7 percent zinc, 7 ounces of silver, less than 1 percent copper, and 1/10 ounce gold to the ton and was all produced underground (James and

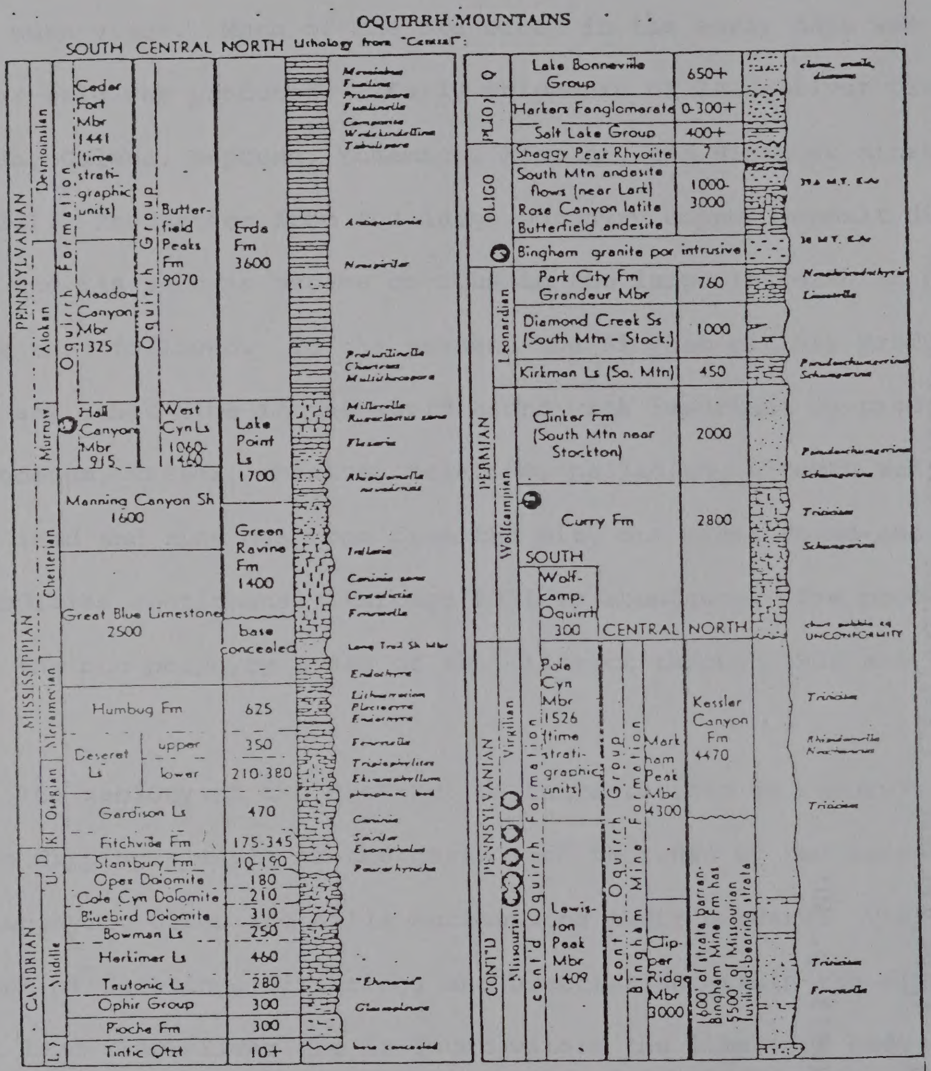
Table 29: Production of non-porphyry ores from the Bingham district, 1863-1971 (Lark-U. S.-Carr Fork).

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper Pounds	Gold/Ozs.	Silver/Ozs.	Value
1863-1964	43,947,000	4,180,279,000	1,709,091,000	816,498,000	2,377,000	136,125,000	$777,138,000
1965-1971	1,701,000	305,000,000	177,000,000	15,194,000	45,000	6,609,000	89,904,000
Totals	45,648,000	4,485,279,000	1,886,091,000	831,692,000	2,422,000	142,734,000	$867,042,000

Source: James, Allan (1973, p. 40)

Figure 100:

STRATIGRAPHIC COLUMN FOR THE OQUIRRH MOUNTAINS

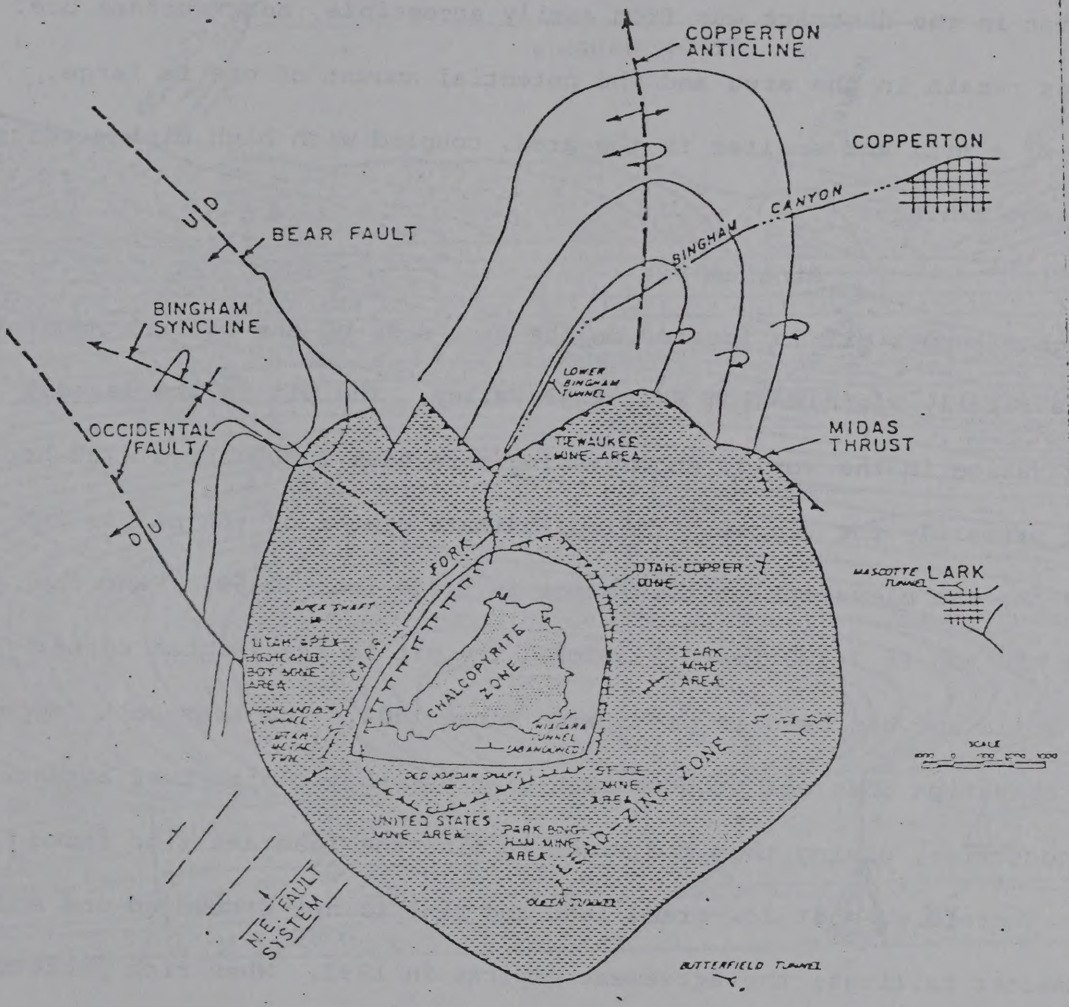


After: Gilluly (1932); Bissell and others (1959); Bissell (1962a); Welsh and James (1961); Tooker and Roberts (1961); Zeller (1958); Proctor (1959); Wells (1963); Eardley and Croaderty (1950); Eardley (1968); Permian: McKee and others (1967); Upper Paleozoic: Tooker and Roberts (1970); Pennsylvanian: Rich (1971); Radiometric dates: Armstrong (1970a); Moore and others (1968)

● Ore-bearing horizons

Adapted from Hintze, 1973, p. 129

Figure 101:
METAL ZONING AND PRINCIPAL STRUCTURES OF BINGHAM PIT AREA



Adapted from James and others, 1961, p. 85

others, 1961, p. 95). The last underground mine that operated in the Bingham district was the U. S. and Lark mine, which produced 6,000 tons of ore per week before closing in November of 1971. The closing of the International smelter in Tooele and the custom mill in Midvale caused the mine's shut-down. The early lead production in the district was from easily accessible, near surface ore. Large reserves remain in the area and the potential amount of ore is large, but the lack of a mill and smelter in the area, coupled with high mining costs, preclude present mining.

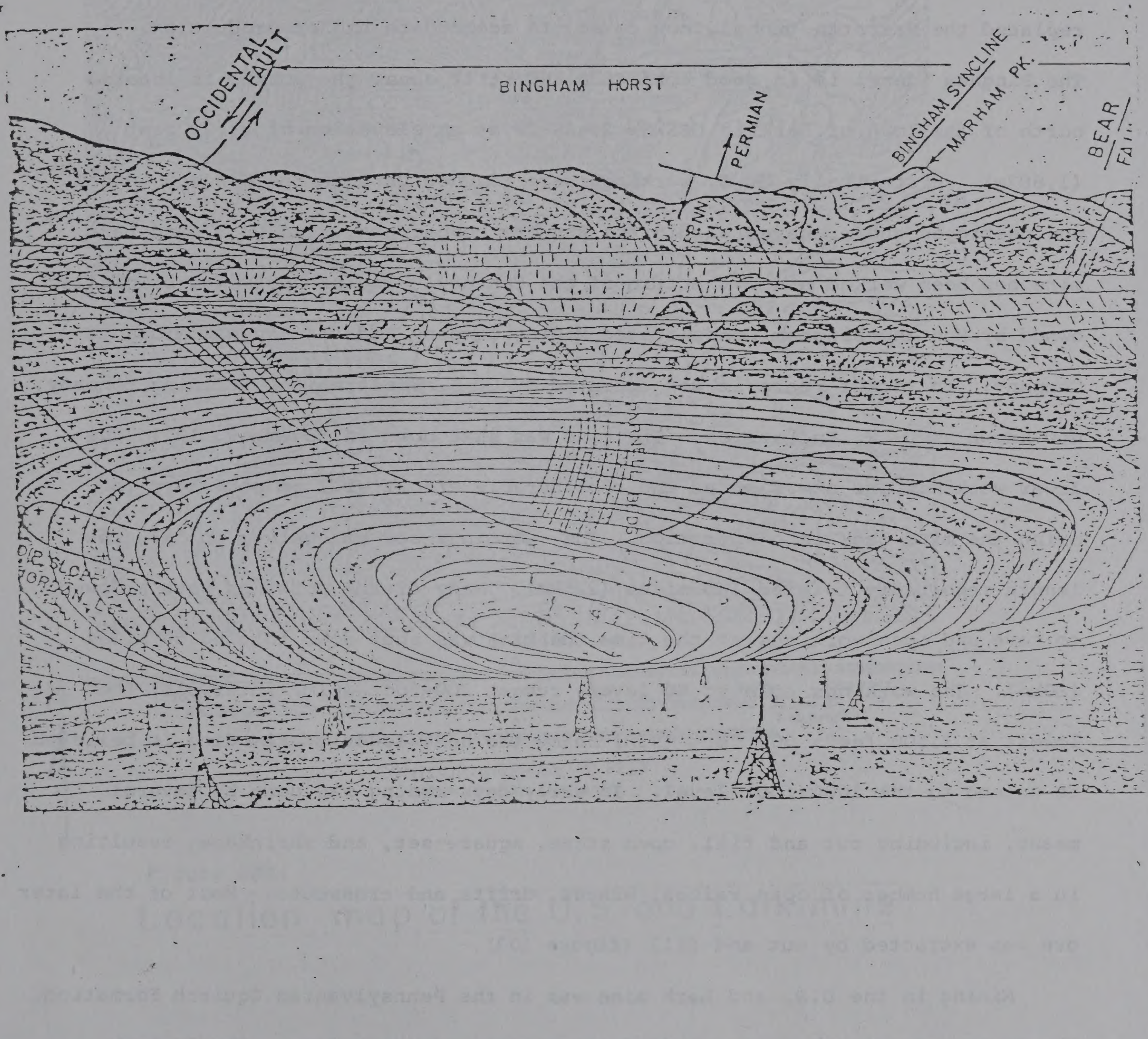
Bingham Pit

The Bingham copper pit is located on the east side of the Oquirrh Mountains, the dumps are readily visible from Salt Lake Valley. The pit is the largest man-made excavation in the world, encompassing more than 1,800 acres (732 hectares), and is mined primarily for copper. The approximate center of the pit is in NENENW 35-3S-5W; the elevation at the bottom is 5,240 feet (1,597m) and the elevation at the top is 7,780 feet (2,371m). The pit is the largest copper mine in the world and has been in production since 1904. The Kennecott Copper Corporation operation does not produce lead-zinc due to a contractual agreement with U.V. Industries, giving them the right to mine the lead and zinc found in the pit. Therefore, most low-grade lead and zinc is not recovered and ends up in the smelter tailings; the agreement expires in 1992. When rich pockets are uncovered in the pit operation, U. V. Industries are called in to do the mining. Lead-zinc mineralization is occasionally uncovered in the Jordan Limestone as replacements and fissure fillings. Ore is extracted by means of front-end loaders, dumped into tractor-trailers and hauled to the Park City area to be concentrated in U. V.'s mill (figure 102). The ore minerals are galena and sphalerite in a gangue of calcite. An estimated ore potential of 60 to 100 thousand tons may remain in the pit area.

United States and Lark Mine

The United States and Lark mine workings cover two areas located to the

Figure 102:
BINGHAM OPEN PIT SHOWING BINGHAM SYNCLINE AND HORST



Adapted from James and others, 1961, p. 51

east and southeast of the Bingham copper pit. The Lark section is located east of the pit and west of the town of Lark and the U. S. section is south-southwest of the Lark section. Access to U. S. and Lark workings is through the Bingham tunnel, started in 1949 and finished in 1953. The Bingham tunnel replaced the Mascotte tunnel, now caved, to accomodate higher production. The Bingham tunnel is in good condition and still open, the portal is located north of the town of Lark in NESWSW 29-3S-2W at an elevation of 5,520 feet (1,682m). Historically U. S. workings were reached through the Niagara tunnel, now destroyed and/or caved within the Bingham copper pit. The U. S. and Lark mine has been worked since the turn of the Century. The property was originally owned by Montana-Bingham Consolidated Mining Company and the Bingham Mines Company. In recent years it was operated by U. S. Smelting and Refining Company, now known as U. V. Industries. The mine was shut down in November, 1971, the lower workings are now flooded and considerable effort will be necessary to bring the mine back into operation. The workings are extensive; in 1953 the length reportedly totaled 140 miles (225km). Many of the workings were allowed to cave and open workings at the time the mine was shut down totaled 50 miles (80km). The workings consist of levels run at 200-foot (61m) intervals; the lowest at 2,500 feet, 300 feet (91m) below the next lowest. Flooding is believed to extend to the 1000-foot level. In early days mining was done by several means, including cut and fill, open stope, square-set, and shrinkage, resulting in a large number of open raises, winzes, drifts and crosscuts. Most of the later ore was extracted by cut and fill (figure 103).

Mining in the U.S. and Lark mine was in the Pennsylvanian Oquirrh Formation. The Oquirrh consists of interbedded limestones and quartzites. The Oquirrh exhibits varying degrees of metamorphism with lead-zinc mineralization in most of the important limestone units. Some intrusive rock has also been encountered, consisting of stocks, dikes, and sills, cutting through much of the sedimentary series (Rubright and Hunt, 1968, p. 890). The geologic structure is complex and

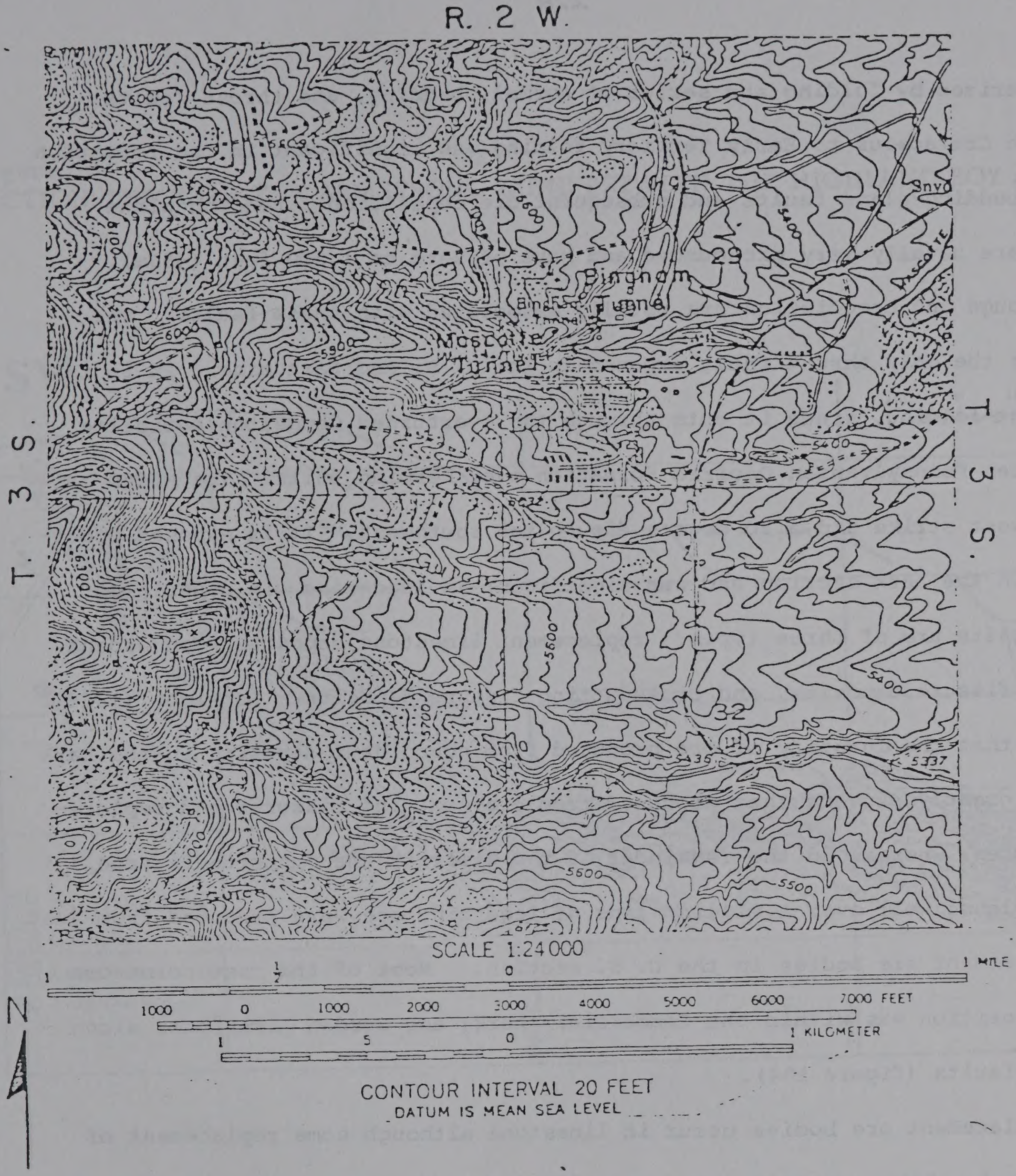


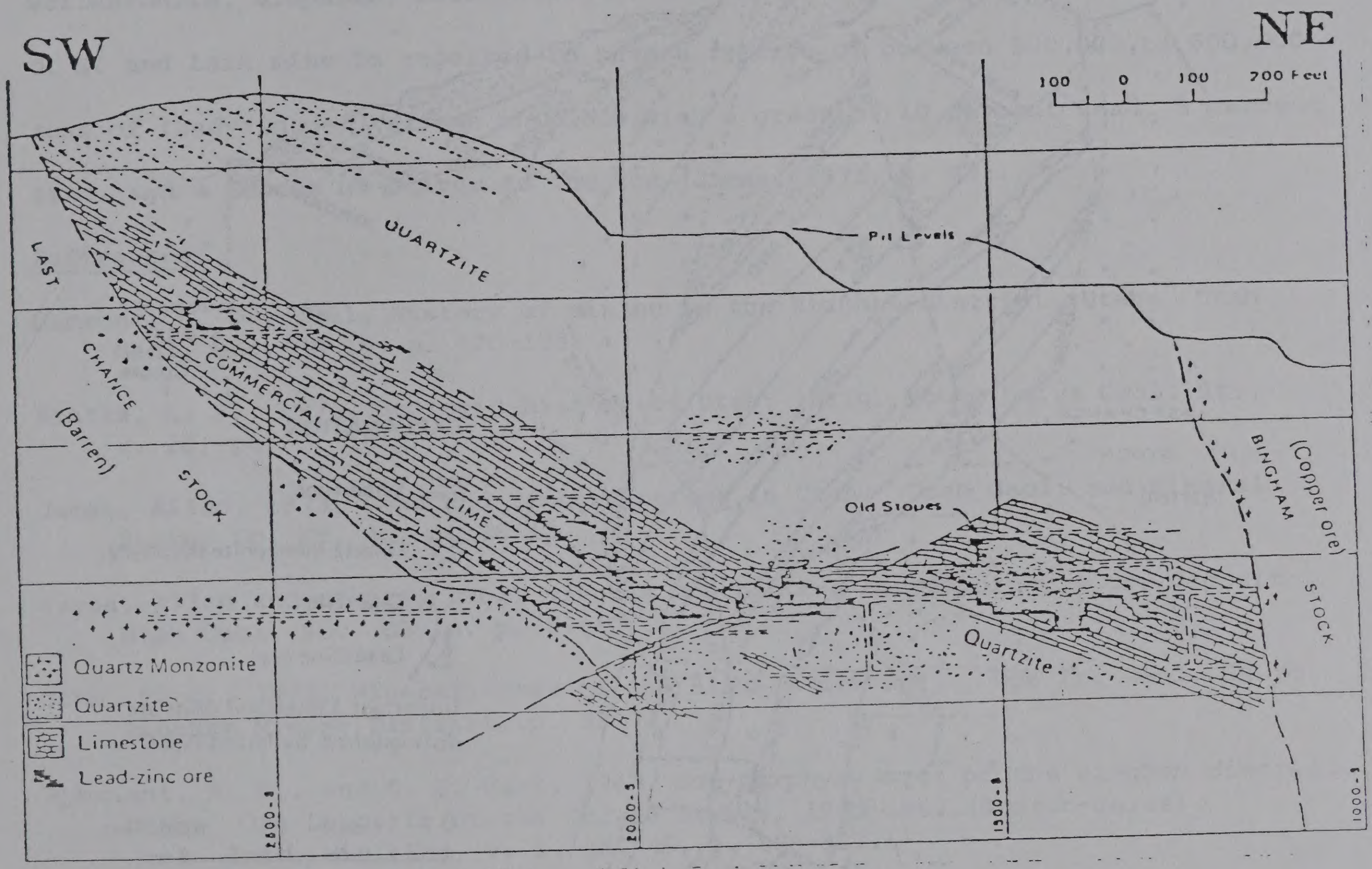
Figure 103:

Location map of the U.S. and Lark mine

characterized by folding and series of normal, bedding, and thrust faults. The Late Cretaceous to Early Tertiary folding was significant in the formation of the bedding-plane faults and subsequent ore deposition. Bedding plane faults are usually very pronounced and have offsets to 1,500 feet (457m). Fault gouge and brecciation are usually associated with these faults. The Midas is the only thrust fault exposed in the U. S. and Lark mine. It is in part post-folding, since it cuts through the overturned Copperton anticline and places Pennsylvanian Oquirrh Formation over Permian units. The Midas has a northwest strike and a 20 degree dip to the southwest. It is exposed underground in the Lark section and was significant in lead-zinc ore deposition. Ore deposits are of three types: replacement limestone deposits, concordant bedding fissure deposits, and crosscutting fissure deposits. Rubright (1968) reports that the quantity of ore produced from concordant deposits in the Lark section greatly exceeds that produced from crosscutting fissures and replacement bodies; whereas in the remainder of the district the opposite is true. Nevertheless, well over a million tons of lead-zinc ore were produced from just two concordant ore bodies in the U. S. section. Most of the concordant ore body deposition was within the Commercial, Lark, and Jordan Limestones along bedding faults (figure 104).

Replacement ore bodies occur in limestone although some replacement of quartzite has been reported. The ore bodies are quite large, some extending several thousands of feet. They are pipe-like or tabular in shape and are usually found in the Commercial and Jordan Limestones (figure 105). Crosscutting fissures within most of the area of lead-zinc mineralization were very favorable to ore deposition. However, in the U. S. section the fissures had very few significant ore deposits, possibly the result of lower porosity (Rubright, 1968, p. 902). In the Lark section ore associated with fissures was important and formed pipe-like deposits. The most noteworthy fissure was the Lark vein, probably a main conduit for ore solutions. The Lark vein length

Figure 104:
SECTION THROUGH THE ARMSTRONG MINE BETWEEN THE HIGHLAND BOY AND US MIN



Adapted from James and others, 1961, p. 94

Figure 105:

VERTICAL NORTH-SOUTH SECTION OF THE U.S. MINE

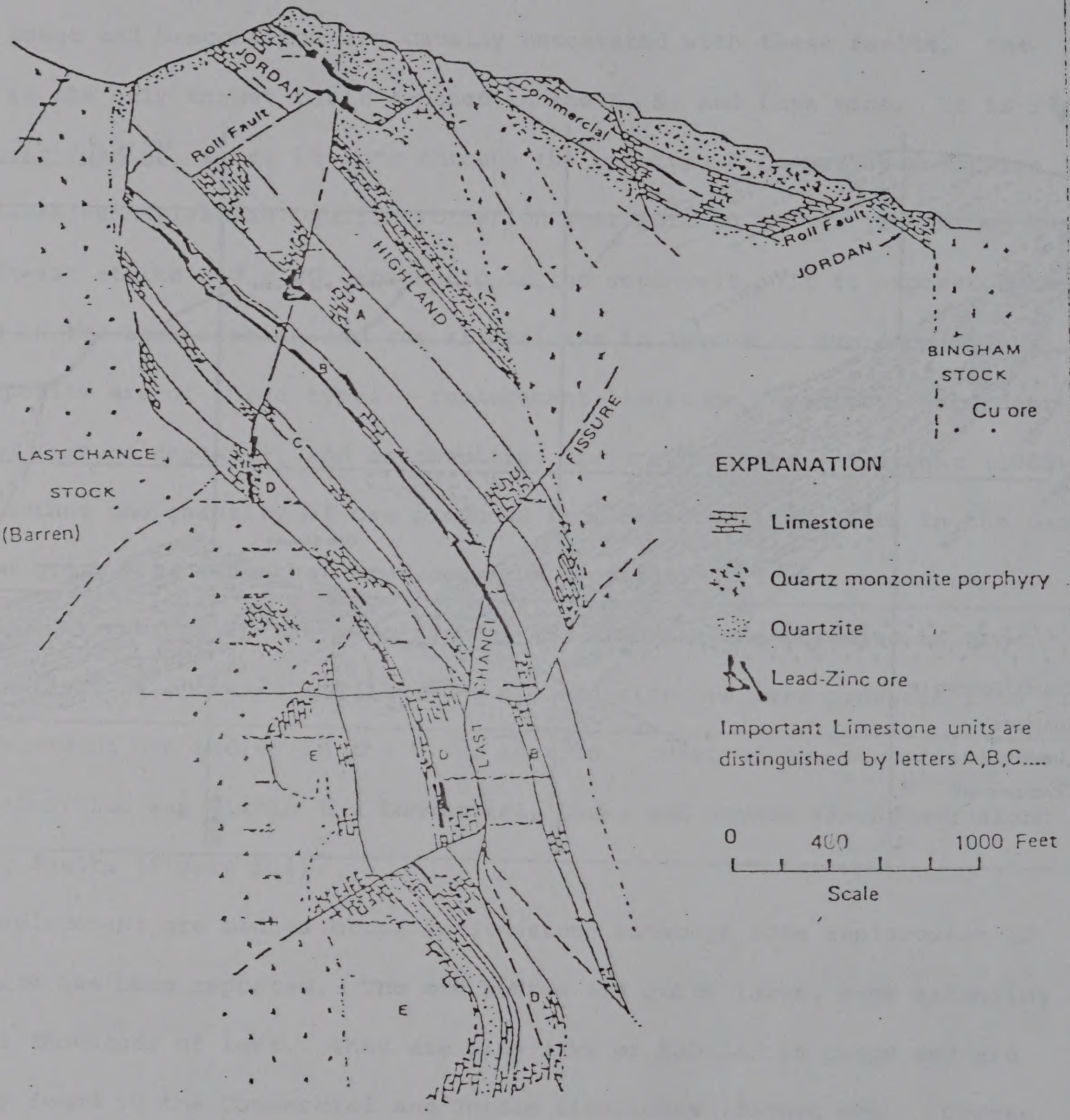


Figure 19. Vertical north-south section of the U. S. mine (from Rubright and Hart, 1968).

Adapted from James, 1973, p. 41

may have a vertical length of more than 3,000 feet (914m). The ore minerals of the mine include galena, cerussite, sphalerite, smithsonite, azurite, bornite, malachite, chalcocite, arsenopyrite, native copper, chalcopyrite, native gold and silver, massicot, tetrahedrite, and cinnabar. Gangue minerals include pyrite, gypsum, calcite, barite, quartz, opal, saponite, chlorite, talc, mica, wollastonite, diopside, rhodochrosite, stibnite, sericite, and biotite. The U. S. and Lark mine is reported to have a reserve of between 500,000 to 600,000 tons of lead-zinc-silver ore in place with a grade of 10 percent lead, 8 percent zinc, and 4 ounces of silver to the ton (James, 1973, p. 42).

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Big and Little Cottonwood Districts

Big and Little Cottonwood mining districts are located in the Wasatch Mountains in adjacent canyons bearing the same names. A mountain ridge divides the two districts which are located about 20 miles southeast of Salt Lake City. Originally they were part of the Wasatch district, in 1864 the name was changed to Mountain Lake district and included the area from Parleys Creek south to

Utah Lake and from the Jordan Valley east to the summit of the mountains. In 1870 the Mountain Lake mining district was subdivided into three districts: Big Cottonwood, Little Cottonwood, and American Fork. The original discovery of mineralization was made in 1865 by Silas Brain, who located a claim on the north side of Little Cottonwood Canyon near Alta (Calkins and Butler, 1943, p. 72). In 1869 F. B. Woodman discovered the Emma ore body in Little Cottonwood Canyon and caused a feverish search by prospectors for similar deposits. Several important discoveries followed. Big and Little Cottonwood mining districts have been important producers of lead and zinc along with silver, gold, copper and tungsten. Lead production amounts to almost 252 million pounds worth 15.7 million dollars at the time of production. Zinc production amounts to almost 24.5 million pounds with a value of 3 million dollars. These figures and those for copper, gold, and silver are given in table 30.

The sedimentary rocks in the districts range in age from Precambrian to Jurassic (figure 106). Igneous rocks consist of stocks, sills and dikes and are Tertiary in age. The sedimentary units have been folded, faulted by normal and reverse faults, shattered, brecciated, and intruded by igneous rocks resulting in the formation of skarns and other metamorphic phenomena (figure 107). Ore bodies are of the following types: veins in intrusive rocks, deposits associated with fissures, bedded deposits, deposits associated with thrust faults, and composite bedded replacements and thrust-fault replacements. Some reserves remain in the old workings and exploration along known ore-producing trends and structures should prove worthwhile.

Maxfield Mine

The Maxfield mine portal is on the north side of Big Cottonwood Canyon at the mouth of Mill A Gulch. The portal of the lower drain tunnel (James) is in NWNESE 14-2S-2E at an elevation of 6,965 feet (2,123m). The Maxfield and other mines located in the western part of the Big and Little Cottonwood districts are located on the map, figure 108. The mineralization was dis-

Table 30:

Gold, silver, copper, lead, and zinc produced in Big and Little Cottonwood mining districts, 1867-1976, in terms of recovered metals

[Compiled by V. C. Heikes, revised and brought to date by C. N. Gerry, U. S. Bureau of Mines. Additions since 1927 from U. S. Bureau of Mines, Mineral Resources and Mineral Yearbook, chapters by C. N. Gerry, Paul Luff, and T. H. Miller]

Period	Number of mines	Ore mined (short tons)	Gold		Silver		Copper		Lead		Zinc		Total value
			Fine ounces	Value	Fine ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
1867-70	....	5,573	59.99	$1,210	703,138	$933,667	....	....	6,141,800	$387,018	....	....	$1,321,955
1871-80	....	133,796	3,585.02	74,109	6,250,000	7,870,458	....	....	95,201,098	5,450,511	....	....	13,401,108
1881-90	....	22,515	5,426.90	112,184	883,031	927,886	....	....	14,784,900	662,998	....	....	1,703,068
1891-1900	....	13,885	7,581.38	156,721	707,731	525,144	....	....	8,457,869	323,954	....	....	1,005,819
1867-1900	....	175,769	16,653.29	344,254	8,552,903	10,263,155	....	....	124,889,567	6,824,541	....	....	17,431,950
1901	3	935	161.19	3,332	37,532	22,519	....	....	300,298	12,913	....	....	38,764
1902	4	850	146.53	3,029	34,120	18,084	58,490	$7,136	272,999	11,193	....	....	39,442
1903	5	1,077	85.21	1,762	69,336	37,441	102,260	14,010	552,483	23,204	....	....	76,417
1904	6	4,878	306.36	6,333	106,219	60,828	235,832	29,479	1,190,005	52,063	....	....	148,703
1905	6	26,003	919.09	19,638	371,683	221,496	811,639	126,616	1,702,258	80,006	....	....	450,756
1906	10	20,801	762.05	15,753	345,102	231,218	1,193,743	230,392	1,922,276	109,570	....	....	586,933
1907	11	19,896	976.93	20,195	399,417	263,615	1,071,238	214,848	2,337,924	123,910	....	....	622,568
1908	21	5,866	321.35	6,643	63,246	33,520	269,212	35,536	603,840	25,362	....	....	101,061
1909	15	13,208	335.72	6,940	158,867	82,611	1,842,711	239,553	332,475	14,296	....	....	343,400
1910	17	14,203	381.87	7,894	202,010	109,085	804,018	102,110	1,102,907	48,528	....	....	207,617
1901-10 [1]	....	108,617	4,427.23	91,519	1,787,562	1,083,417	6,392,143	999,680	10,317,465	501,015	....	....	2,675,661
1911	12	6,010	139.17	2,877	158,448	83,978	407,719	50,965	1,013,608	46,963	....	....	184,783
1912	15	6,566	142.46	2,945	186,183	114,503	386,963	63,849	1,135,191	51,084	....	....	232,381
1913	12	5,167	112.09	2,317	93,821	56,668	136,901	21,219	1,091,617	48,031	....	....	128,235
1914	25	12,583	372.25	7,695	242,825	134,282	214,971	28,591	2,887,109	112,598	8,804	$449	283,615
1915	18	24,590	430.39	8,897	445,111	225,671	334,941	58,615	12,263,403	578,380	229,663	28,478	898,041
1916	31	41,960	1,035.90	21,414	755,980	497,435	819,192	201,521	15,061,273	1,039,228	60,746	8,140	1,767,738
1917	32	48,203	900.31	18,611	917,512	756,030	1,163,081	317,522	11,927,552	1,025,770	21,721	2,216	2,120,149
1918	23	35,269	583.69	12,066	482,136	482,136	1,715,969	423,814	6,007,253	426,515	1,121	102	1,344,663
1919	19	21,766	384.41	7,947	321,426	359,907	916,019	170,385	4,857,211	257,432	....	....	795,781
1920	15	18,299	329.21	6,806	413,863	451,110	566,603	101,144	5,460,436	439,955	....	....	1,002,015
1911-20	....	220,413	4,429.94	91,575	4,017,305	3,161,810	6,661,795	1,440,655	61,773,653	4,023,956	322,055	39,385	8,757,381
1921	16	14,303	241.92	5,001	310,708	310,708	296,296	38,222	4,450,201	200,664	....	....	554,595
1922	14	17,450	279.07	5,769	204,477	204,477	755,995	102,059	5,508,133	302,918	....	....	705,253
1923	14	18,671	206.75	4,274	304,355	208,771	344,553	50,850	7,662,932	536,405	....	....	890,100
1924	11	16,628	244.68	5,058	423,176	283,528	218,300	32,265	6,256,829	500,540	....	....	821,397
1925	16	13,565	279.66	5,781	264,753	176,708	212,221	30,138	4,748,256	413,098	....	....	625,813
1926	15	10,907	246.52	5,096	206,498	128,855	449,069	63,870	3,194,890	255,591	360,270	27,021	479,433
1927	11	5,181	245.99	5,085	148,115	83,981	219,337	32,663	2,017,283	127,089	1,666	107	248,925
1928	9	1,518	137.34	2,839	30,816	18,015	139,489	20,086	292,975	16,993	....	....	57,963
1929	7	1,814	33.23	687	30,212	16,103	57,989	10,206	346,381	21,822	87,213	6,756	54,574
1930	7	1,401	61.15	1,264	15,770	6,075	25,646	3,334	250,180	12,509	....	....	23,182
1921-30	....	101,510	1,976.31	40,851	2,078,919	1,617,341	2,776,895	382,491	34,737,060	2,387,665	449,149	32,884	4,461,235
1931	10	657	153.70	3,177	20,317	5,892	10,306	937	234,043	8,093	13,017	405	10,194
1932	10	488	46.58	963	9,337	2,633	4,710	280	217,024	6,538	1,446	44	10,474
1933	9	1,434	98.88	[1] 2,527	11,041	3,864	8,852	566	430,851	15,034	354,456	14,887	37,778
1934	9	1,881	168.21	5,880	30,356	23,503	34,612	2,769	505,162	22,021	181,000	7,012	62,085
1935	10	1,970	160.20	5,607	38,960	28,009	40,723	3,380	542,775	21,711	100,091	4,404	63,111
1936	12	2,800	286.80	10,038	60,632	39,137	46,598	4,195	713,818	32,837	29,480	1,474	87,681
1937	9	7,858	363.00	12,705	132,100	102,488	249,000	30,129	2,175,000	128,325	115,600	7,514	281,161
1938	9	3,066	282.00	9,870	39,122	25,291	89,919	8,815	680,318	26,696	64,542	3,098	73,770
1939	10	2,653	248.00	8,680	38,954	25,081	69,125	7,189	366,319	17,217	86,789	4,513	62,683
1940	10	2,634	210.00	7,350	33,293	23,675	81,000	9,153	231,800	11,590	39,603	2,495	54,263
1931-1940	....	25,510	2,017.40	66,797	498,420	279,570	633,875	67,429	6,068,770	291,582	989,024	46,836	752,200

Table 30 continued:

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1941	1,463	262,000	57,000	64,000	197.00	25,830	$52,024
1942	1,077	108,700	90,900	44,000	106.00	15,878	36,062
1943	794	167,600	128,000	9,900	46.00	7,709	34,773
1944	329	50,800	43,500	10,400	27.00	8,408	17,351
1945	856	77,000	---	69,400	29.00	14,760	27,502
1946	838	98,400	1,500	45,000	78.00	12,130	30,685
1947	951	233,500	7,800	67,000	30.00	17,926	65,911
1948	2,489	746,700	482,100	66,600	33.00	20,758	232,172
1949	4,796	1,284,000	851,800	56,000	98.00	35,229	354,841
1950	4,027	741,800	866,900	54,000	50.00	23,423	257,424
1941-1950	17,620	3,770,500	2,529,500	486,300	694.00	182,051	$1,108,745
1951	931	117,100	246,100	11,000	10.00	5,941	$246,100
1952	387	89,606	22,200	4,700	15.00	6,107	24,301
1953	40	100	---	3,900	1.00	97	1,255
1954	487	29,800	23,000	13,100	21.00	5,656	16,281
1955	49,108	1,419,500	6,370,000	23,000	21.00	14,505	1,017,458
1956	48,541	940,100	7,147,200	23,900	9.00	6,879	1,143,460
1957-1959				no production			
1960	?	2,045,400	1,692,900	125,900	81.00	56,559	560,117
1951-1960	?	4,641,606	15,501,400	205,500	158.00	95,744	$3,008,972
1961	?	2,568,500	2,175,900	364,500	97.00	162,430	$804,199
1962	?	683,200	536,500	71,400	20.00	31,498	184,197
1963	?	547,700	378,500	64,600	26.00	30,024	157,528
1964	?	459,300	211,900	68,100	27.00	32,250	149,923
1965	?	352,500	146,400	294,800	48.00	44,951	229,070
1966	?	536,800	737,400	80,200	30.00	39,815	272,413
1967	?	444,900	509,700	10,200	6.00	12,371	153,301
1968-1970				no production			
1961-1970	?	5,592,900	4,696,300	953,800	254.00	353,339	$1,950,631
1971-1976				no production			

Table 30 continued:

GRAND TOTALS

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1967-1976	830,023[1]	251,811,521	24,487,428	18,050,899	30,610.17	17,476,243	$40,146,775

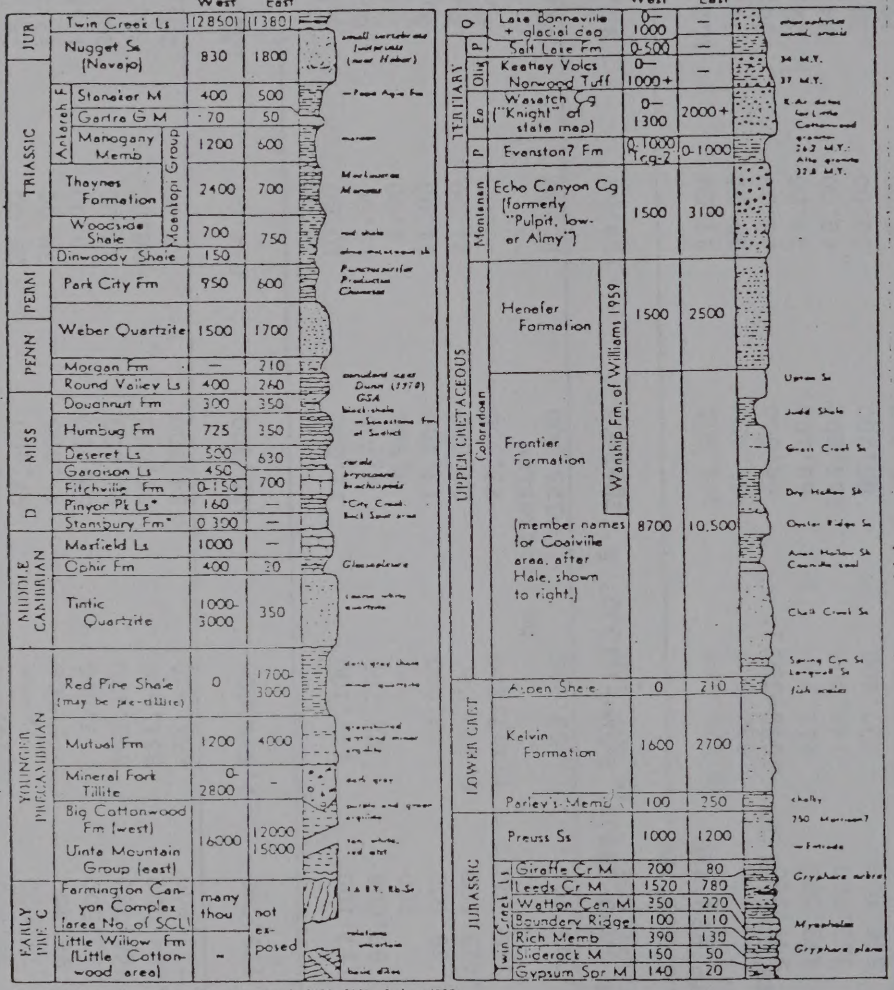
[1] Recorded tonnages plus estimates for 1960-1967.

Estimated lead value: $15,668,526
Estimated zinc value: 3,062,158

Source of information for 1960-1967: Stowe (1975, p. 50-54)

Figure 106:
STRATIGRAPHIC COLUMN OF THE WASATCH MOUNTAINS

a.-CENTRAL WASATCH MOUNTAINS NEAR SALT LAKE CITY (West)
b.-WESTERN UINTA MOUNTAINS - COALVILLE (East)



		West	East
JUR	Twin Creek Ls	(12850)	(1380)
	Nugget Ss (Navajo)	830	1800
TRIASSIC	Ankareh F. Stanaker M	400	500
	Ankareh F. Gartra G M	·70	50
	Ankareh F. Mahogany Memb (Moenkopi Group)	1200	600
	Thaynes Formation (Moenkopi Group)	2400	700
	Woodside Shale (Moenkopi Group)	700	750
	Dinwoody Shale	150	
PERM	Park City Fm	950	600
PENN	Weber Quartzite	1500	1700
	Morgan Fm	—	210
	Round Valley Ls	400	260
MISS	Doughnut Fm	300	350
	Humbug Fm	725	350
	Deseret Ls	500	630
	Gardison Ls	450	700
	Fitchville Fm	0-150	
D	Pinyon Pk Ls*	160	—
	Stansbury Fm*	0 300	—
MIDDLE CAMBRIAN	Maxfield Ls	1000	—
	Ophir Fm	400	20
	Tintic Quartzite	1000-3000	350
YOUNGER PRECAMBRIAN	Red Pine Shale (may be pre-tillite)	0	1700-3000
	Mutual Fm	1200	4000
	Mineral Fork Tillite	0-2800	-
	Big Cottonwood Fm (west) Uinta Mountain Group (east)	16000	12000 15000
EARLY PRE C	Farmington Canyon Complex (area No. of SLC)	many thou	not exposed
	Little Willow Fm (Little Cottonwood area)	-	

		West	East
Q	Lake Bonneville + glacial dep	0—1000	—
TERTIARY P	Salt Lake Fm	0-500	—
Olig	Keetley Volcs Norwood Tuff	0—1000+	—
Eo	Wasatch Cg ("Knight" of state map)	0—1300	2000+
P	Evanston? Fm	0-1000 Tcg-2	0-1000
UPPER CRETACEOUS Montanan	Echo Canyon Cg (formerly "Pulpit, lower Almy")	1500	3100
Coloradoan	Henefer Formation (Wanship Fm. of Williams 1959)	1500	2500
	Frontier Formation (member names for Coalville area, after Hale, shown to right.)	8700	10,500
LOWER CRET	Aspen Shale	0	210
	Kelvin Formation	1600	2700
	Parley's Memb	100	250
JURASSIC	Preuss Ss	1000	1200
Twin Creek Ls	Giraffe Cr M	200	80
	Leeds Cr M	1520	780
	Watton Cyn M	350	220
	Boundary Ridge	100	110
	Rich Memb	390	130
	Sliderock M	150	50
	Gypsum Spr M	140	20

West (Wasatch Mountains): Crittenden (1963, 1964, 1973); Stokes (1969)
East (Western Uintas): Williams (1957); Sadlick (1957); Cohenour (1959a); Hale and Van De Graaff (1964); Trexler (1966); Bissell (1964b)
Mississippian: Foutz (1966); Arnold and Sadlick (1962); Permian: Williams (1969); Triassic: Smith (1969); Jurassic: Imlay (1967); Cretaceous-Eocene: Hale (1969); Mullens (1969a); Quaternary: Arnow and Mattick (1968); Radiometric dates: Armstrong (1970a); Crittenden (1968, 1973)

Adapted from Hintze, 1973, p. 130

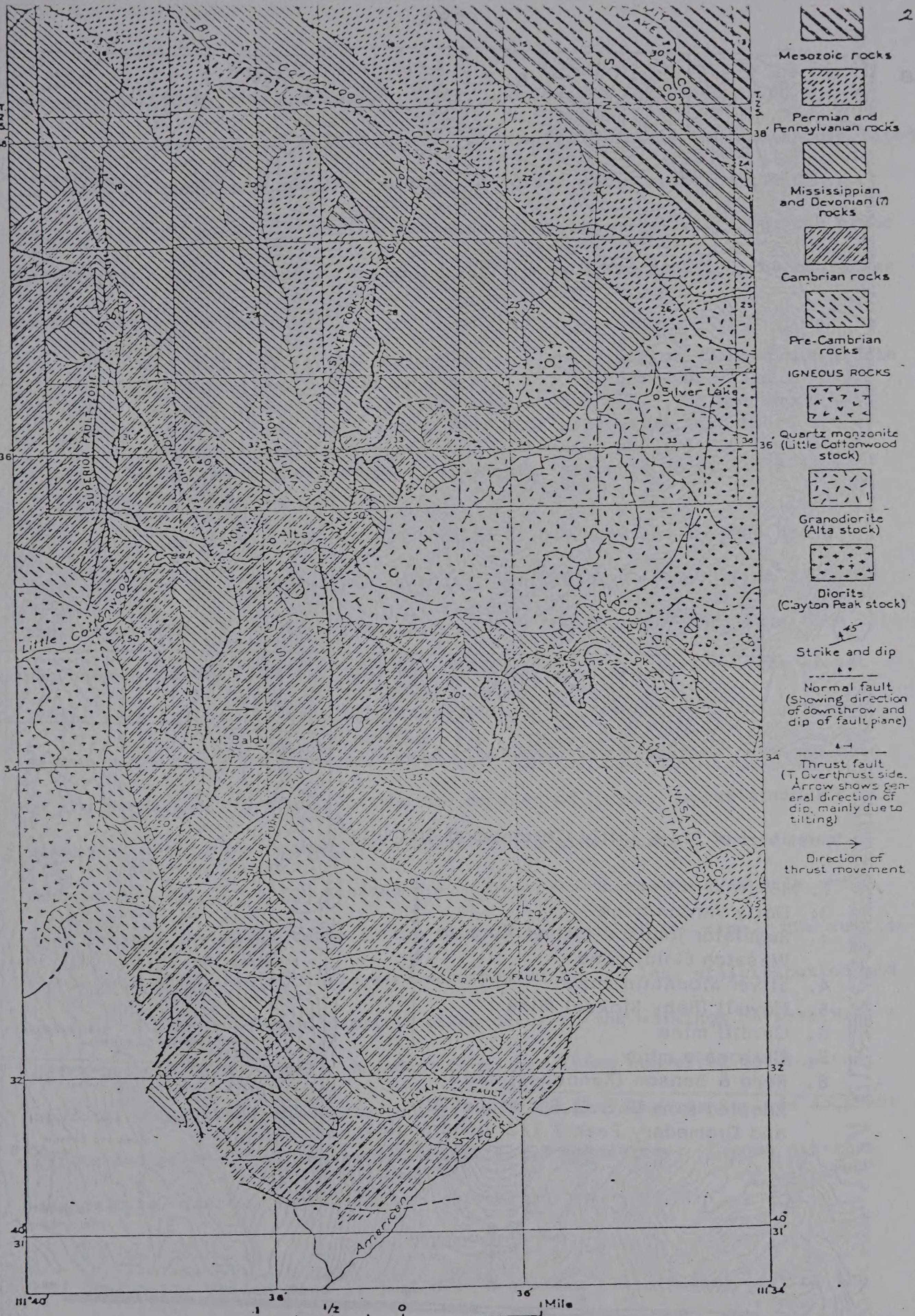


Figure 107: GENERALIZED GEOLOGIC MAP OF COTTONWOOD-AMERICAN FORK AREA.

Source: Calkins and Butler, 1943, p. 54.

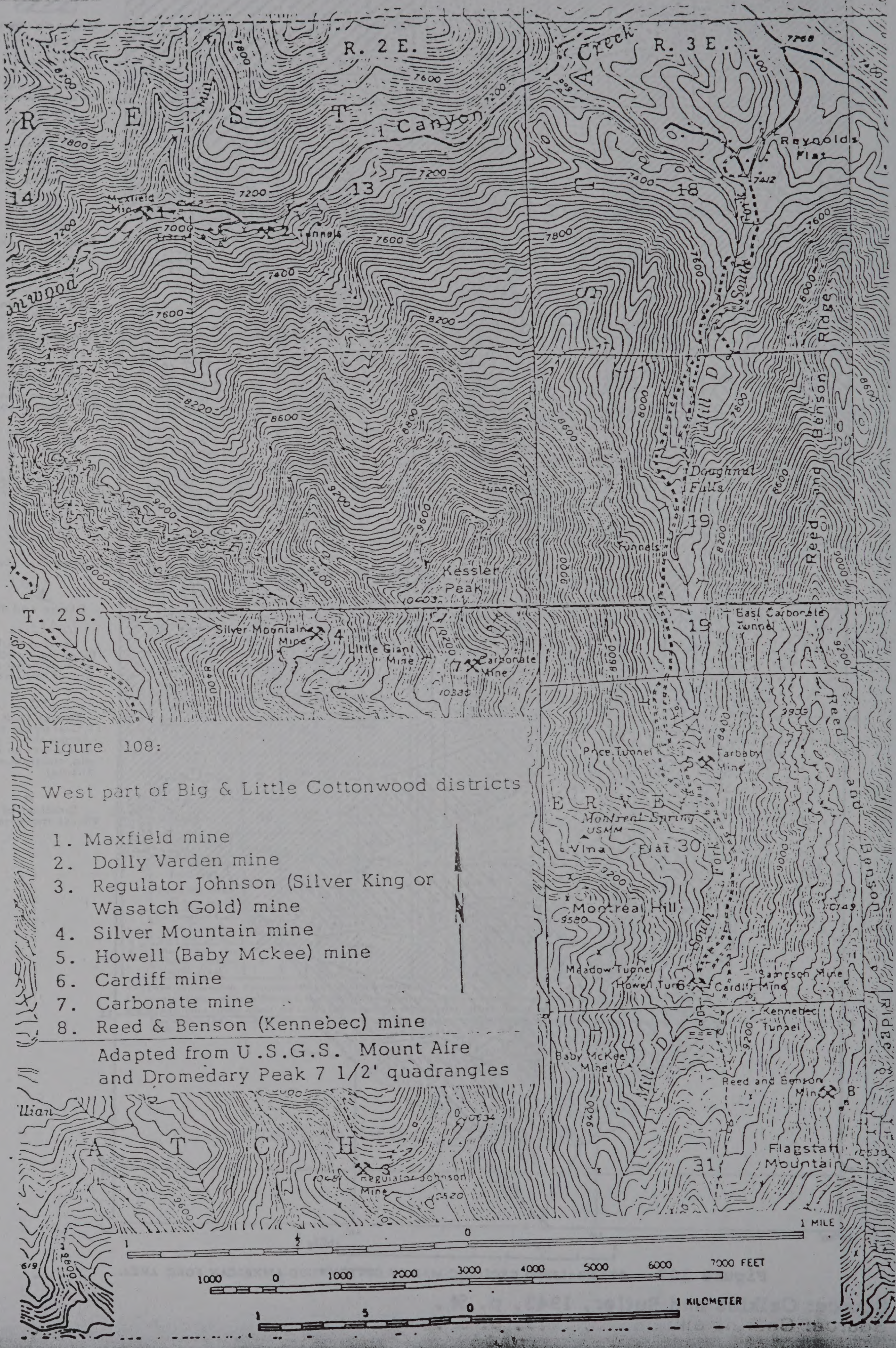


Figure 108:

West part of Big & Little Cottonwood districts

1. Maxfield mine
2. Dolly Varden mine
3. Regulator Johnson (Silver King or Wasatch Gold) mine
4. Silver Mountain mine
5. Howell (Baby Mckee) mine
6. Cardiff mine
7. Carbonate mine
8. Reed & Benson (Kennebec) mine

Adapted from U.S.G.S. Mount Aire and Dromedary Peak 7 1/2' quadrangles covered in 1871 by the Maxfield brothers, who found a sulfide-bearing outcrop on the west side of Mill A Gulch. The Maxfield Mining Co. was incorporated in March, 1879 and the holding includes the oldes water right in the canyon (Huntley, 1880, p. 427). Mining proceeded with some regularity, but the grade and profits varied greatly. The Union Pacific Railroad reported the character of the mine in 1891 (p. 60):

> "The Maxfield is the leading mine of the district. About the middle of 1888 the ore was cut off by a fault... ...it took two years to find it... ...they have taken out 1,100 tons of $70 ore. The ore shoot is about 100 feet long and 2.5 to 3 feet wide and beside this there are a large number of small ore pipes... ...There is about 1,200 feet of stoping on the big ore shoot... ...present stope is about 1,050 feet below the surface."

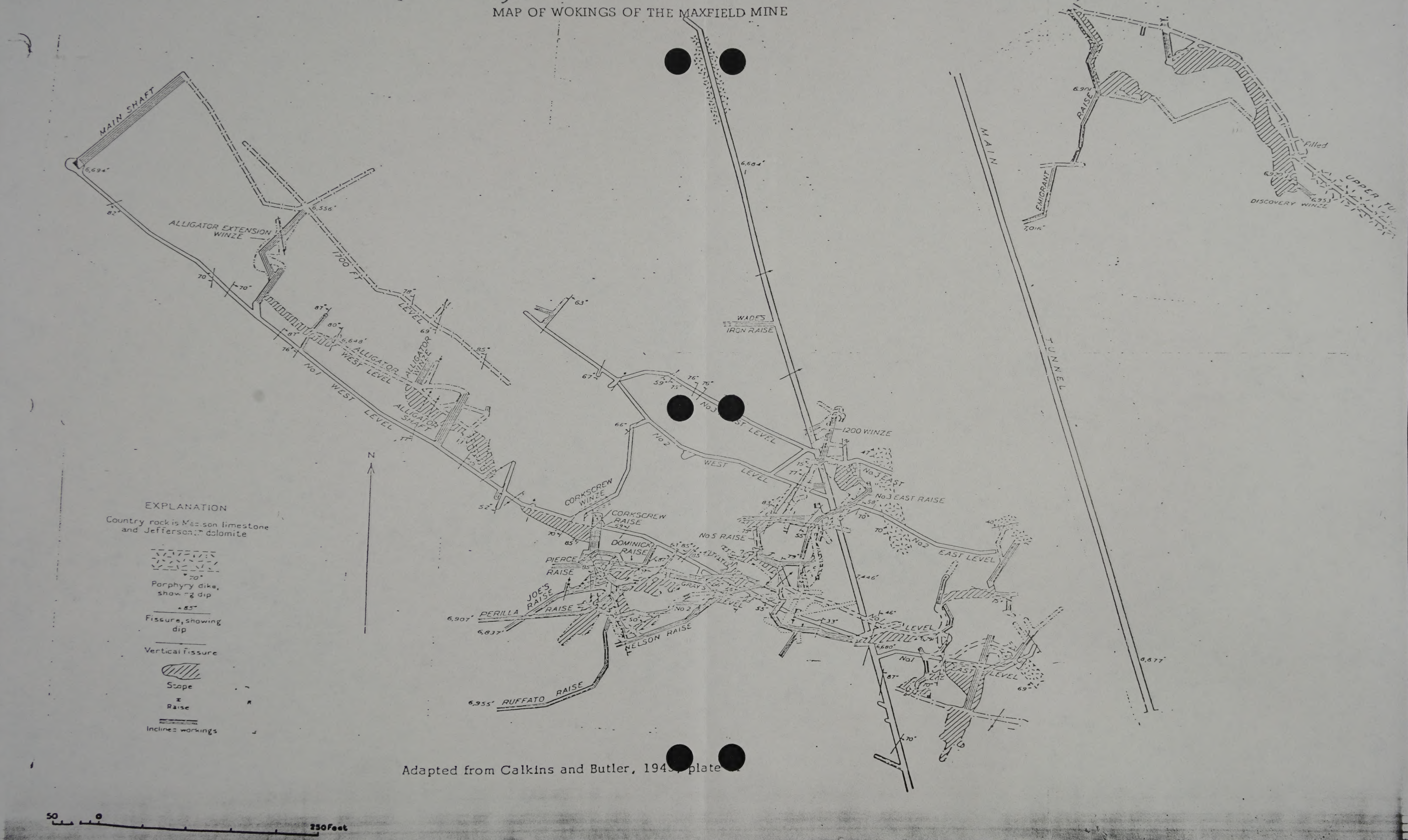
Production to the end of 1890 totaled 22,000 tons and to 1906 had a total value of $1,053,000 (Calkins and Butler, 1943, p. 102). From 1906 to the end of 1919, 5,000 tons were shipped from the property and since then little has been produced. The workings are illustrated in figure 109. The stopes of the mine follow the bedding in the Gardison Limestone, with the larger deposits occurring in a bed of banded blue and white limestone near the base of the formation. Remnants of the ore consist of brown, copper-stained oxide minerals, often with coarse translucent crystalline quartz. Four favorable beds within the formation yielded ore. The ore plunged northwesterly and lies beneath the water table in the main drifts west of the mine. The sulfide-oxide ores at the water table were accompanied by far less silicification and quartz. A number of thin dioritic dikes occur in the workings between Mill A Gulch and the main tunnel. Adjacent rocks have been converted to diopside, epidote, phlogopite, and wollastonite. Sulfide ore minerals include abundant pyrite and galena, and lesser tetrahedrite and sphalerite. Gangue minerals are calcite, quartz, sepiolite, and calc-silicates.

Dolly Varden Mine

The Dolly Varden mine is just over a quarter mile (0.4km) east of the Maxfield mine in SENWNW 13-2S-2E at an elevation of 7,085 feet (2,160m) above

Figure 109.

MAP OF WOKINGS OF THE MAXFIELD MINE



Adapted from Calkins and Butler, 194[illegible] plate [illegible]

sea level. Mineralization was discovered in 1871 and the mine worked until 1885. The value of production through 1880 was about $25,000 and derived primarily from lead-silver ore (Huntley, 1885, p. 430); there has been little activity since. Mine workings consist of three adits and a shaft totaling 1,500 feet (470m) in length; all are presently caved. In 1874 the workings consisted of an incline, down 200 feet (61m), showing a large deposit of low-grade ore worked to a vertical depth of 150 feet. The vein carried 50 percent magnetic hematite, 5 to 1,000 ounces silver, the ore highly prized as a flux at smelters. The deposit was ten feet wide at a depth of 100 feet. A new strike was made at a depth of 270 feet with first assays showing $979 in silver and $12 in gold (Utah Mining Gaz., various issues, 1874).

The mine workings are cut in the upper member of the Ophir Shale and in the lower part of the Maxfield Limestone. Ore was found along an irregular "pipe" with some replacement of limestone (Calkins and Butler, 1943, p. 104). Ore minerals are galena, cerussite, and smithsonite in a gangue of calcite. The chance of finding additional mineralization and ore near this mine is probably small.

Regulator Johnson (Silver King or Wasatch Gold) Mine

Regulator Johnson mine is located south of Big Cottonwood Canyon near the head of Mineral Fork and almost at the divide between Big and Little Cottonwood Canyons. The portals of the upper adits are about 1 mile (1.6km) east-southeast of Lake Blanche in unsurveyed SESENW 36-2S-2E at an elevation of 10,230 feet (3,118m). A jeep trail from Mineral Fork leads to most of the workings. John S. Johnson located the Silver King claims in the early 1870s, ore from shallow workings was transported in sacks on muleback down a trail to Big Cottonwood Canyon. George E. Coxe, in a private report to the Wasatch Gold Mines Co., reported that 43 sacks, having an assay value up to $1,100, were shipped from a stope on the Silver King No. 3 claim. Johnson, Big Cottonwood Silver King Co., and others operated the mine intermittently until

1924 and it is claimed by Coxe that $280,000 worth of ore was shipped prior to 1914, although this figure appears questionable. Between 1899 and 1901, 186.3 short tons of ore were shipped to the old Germania smelter from the Silver King Extension claim and the metal content ranged from 0.3 to 1 ounce in gold per ton, 28 to 139 ounces in silver per ton, 1.5 to 13.5 percent lead, and 19 to 32 percent iron. H. D. Heist, in a private report to the Wasatch Gold Mines Co. in 1936, notes that the main upper level encountered the Silver King fissures at a depth of about 500 feet (152m) and an 80-foot (24m) winze below this level yielded three small shipments yielding smelter returns of $28.40 per ton. It is claimed that $100,000 worth of ore was shipped from this adit and other near-surface workings. Minor production continued into the late 1920s. Wasatch Gold Mines Co. optioned the property and began shipments from the upper workings in August, 1937, and several were sent to the Garfield smelter from 1940 to 1941. A lower tunnel ("Wasatch" mine on U. S. Geol. Survey topographic maps) was driven southward at an elevation of 8,680 feet from Mineral Fork Valley. In 1941 it intersected a pyritic fissure identified as the Silver King at 3,174 feet (967m) from the portal. At this point the fissure contained 6 inches to 6 feet (15cm to 2.9m) of mineralization, not of ore grade. Ore mined from this locality (27.3 short tons), assayed 0.33 ounces per ton gold, 43.8 ounces per ton silver, 6.7 percent lead and 0.37 percent copper. Several hundred feet of drifting along the vein on this level, and subsequent minor additional work by the New Park Mining Company, failed to reveal commercial ore. The Mountain Mines Co., which succeeded Wasatch Gold in 1942, ceased operations in the late 1940s after 72 small shipments having a value of $50,000. Minor lease production was obtained as late as 1952 by G. A. Rich. Maps of the workings appear in James (in preparation, 1977) and total workings exceed 6,000 feet (1,829m).

The host rocks are the Precambrian Mineral Fork Formation not far beneath the Cambrian Tintic Quartzite. The Silver King mineralized fissures

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The host rocks are the Precambrian Mineral Fork Formation not far beneath the Cambrian Tintic Quartzite. The Silver King mineralized fissures

extend northeastward N. 42-47° E. in the workings across the head of Mineral Fork, and shows a mappable displacement in Mill B South Fork (Crittenden, 1965). The same structure was apparently prospected in the American Consolidated-Branborg (meadow) tunnel and South Price tunnel workings in Mill D South Fork. In Mineral Fork the fissure contains a narrow silicic dike in the hanging wall of the mineralized zone. The same dike was encountered on the Wasatch tunnel level, 1400 feet below (Marsell, R. E., Oct. 27, 1941, report to Mountain Mines Co.). A narrow fissure encountered nearer to the portal of the Wasatch tunnel reportedly contained weak mineralization. Prospecting via a raise failed to discover commercial ore. Ore on the upper levels of the Silver King vein is partially oxidized and tended to be considerably higher in grade than mineralization on the Wasatch level. The best ore shoots reportedly occurred where the fissure was cut by north-trending "breaks" or cross faults of very small displacement. Several thousand tons of low grade gold and silver-bearing sulfide ore remains awaiting favorable economic conditions.

Silver Mountain Mine

The Silver Mountain mine is located south of Big Cottonwood Canyon on the southeast slope of Kessler Peak, between Mineral Fork and Mill D South Fork. The portal is in SESESW 24-2S-2E at an elevation of 9,000 feet (2,740m). The mine produced a small amount of ore and was worked intermittently between 1880 and 1918. Discovery of mineralization was in the late 1870s and in 1881 the workings consisted of a 138-foot incline, a tunnel, and a 40-foot winze (Western Min. Gaz., 1881). The total output to 1884 was 1,170 tons of ore and 170 tons shipped that year had a value of $36 a ton (Calkins and Butler, 1943, p. 105). Shipments were again reported in 1886 and 1887; about 300 tons valued at $40,000. Subsequent reports do not mention the mine, but reports for these years tend to be very incomplete. At present, workings total about 1,000 feet, and consist of an irregular incline, a tunnel, and stopes below the tunnel.

The host rock in the mine is the Tintic Quartzite and mineralization consists of fissure fillings of lead-silver ore. Ore minerals at this mine include galena, sphalerite, and probably cerussite and smithsonite. "First Class" ore in 1881 reportedly assayed 65 percent lead and 80 ounces of gold per ton. Jarosite, quartz and calcite are gangue minerals. Additional ore potential for the mine is unknown.

Howell (Baby McKee) Mine

The Howell Group of claims lie south of Big Cottonwood Canyon on the east side of Mill D South Fork. The portal of the lower adit of the mine is approximately 2,600 feet (792m) southeast of Montreal Hill, adjacent to the Cardiff main adit in SWNWNW 31-2S-3E at an elevation of 9,200 feet (2,804m). The ore discovery at the Baby McKee mine was reportedly made in the early 1890s and the report of the Director of the Mint in 1892 indicates 70 tons of ore were produced that year. Development, financed by Capt. A. H. Mayne and Judge W. J. Herrick of Chicago, was through an inclined shaft equipped with a steam hoist. In 1907 the Park City Mining and Power Company installed a water powered compressor and drove an upper adit beneath the old shaft (Salt Lake Min. Rev., several issues) and exposed galena and carbonate ores 135 feet (41m) below the old shaft. A 2,500-foot (620m) lower adit was dug to follow the fissure at greater depths (Calkins and Butler, 1943, pl. 34). In the 1930s, work was begun in Howell ground from the face of the American Metals branch of the Tar Baby tunnel at still greater depth, but small raises and extensive tunneling in this area found only a few tons of ore (James, in preparation, 1977). During all of these prospecting operations intermittent production was achieved by the company and its lessees from raises and winzes in the upper tunnel. Workings consist of nearly 1 mile (1.6km) of adits, plus minor inclines; all are presently caved (figure 110). Most of these workings are on the Baby McKee fissure, though prospecting was attempted on the Alta overthrust. Other mineralized fissures were prospected on the lower tunnel level.

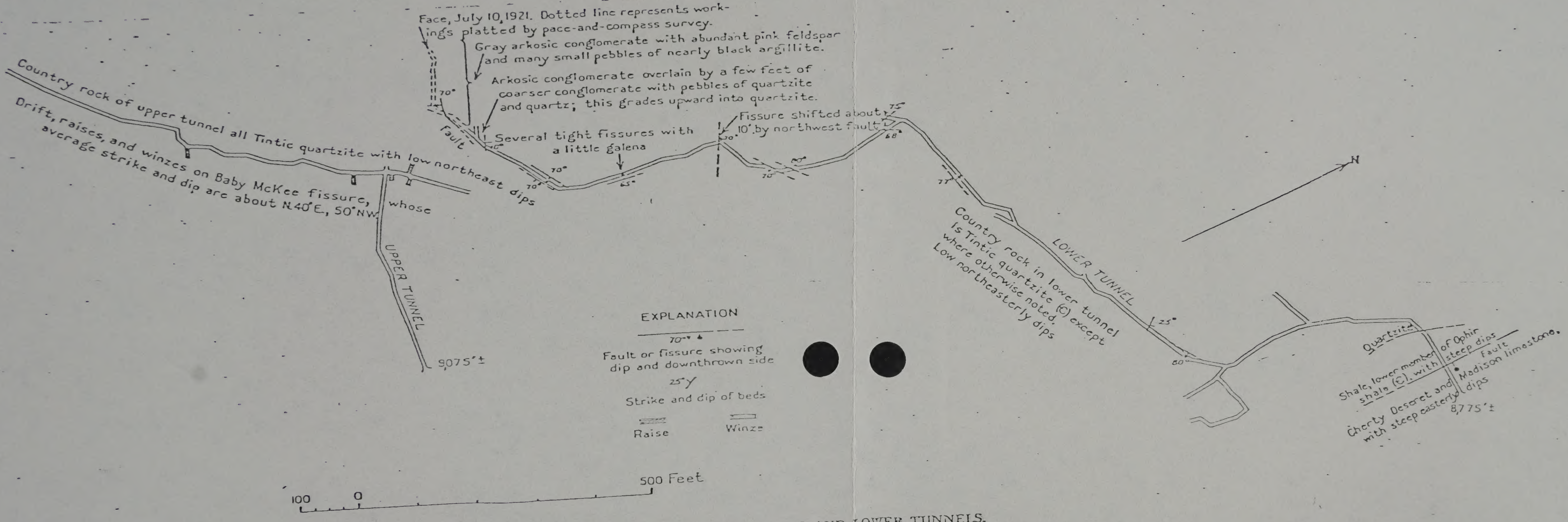
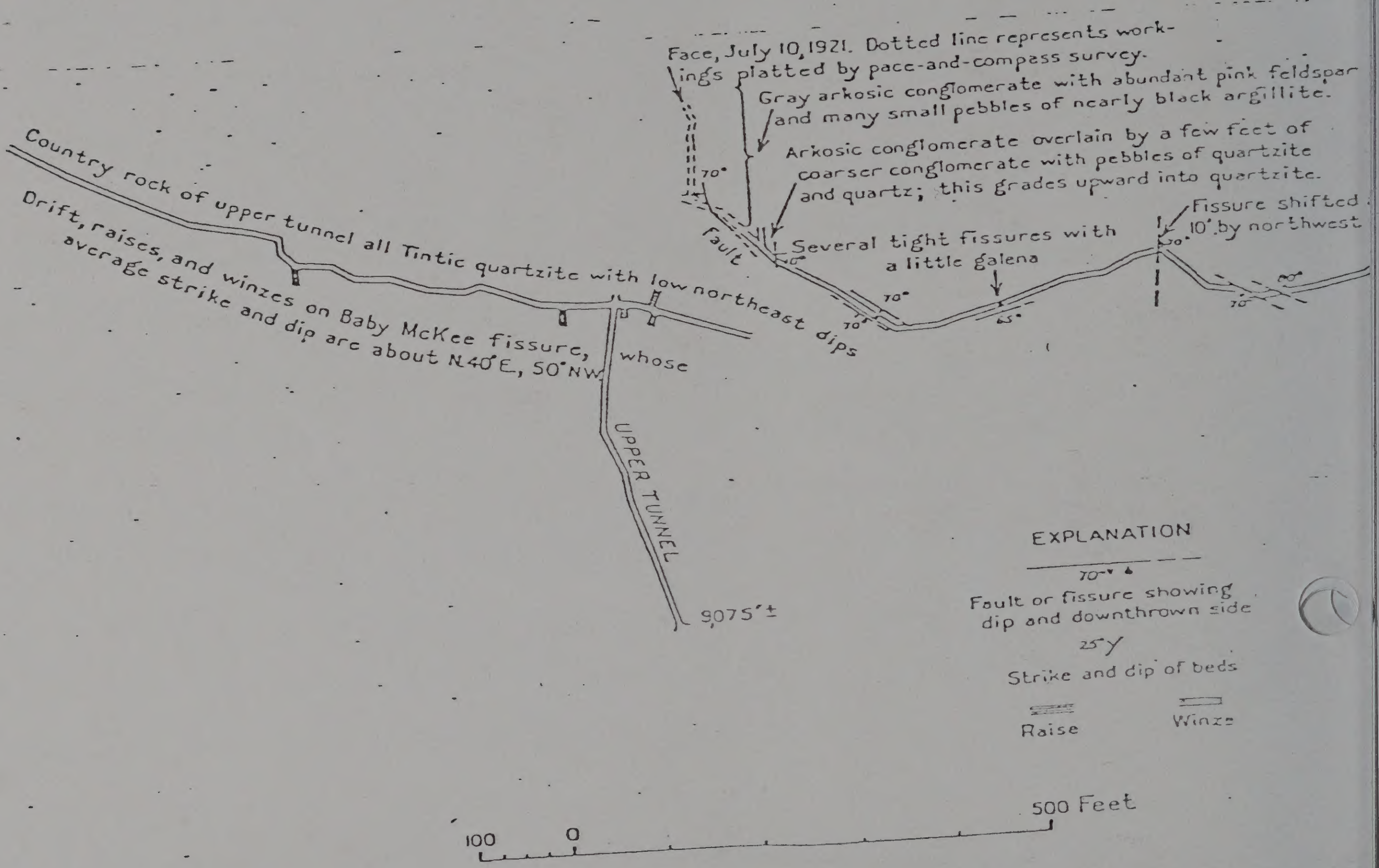

Face, July 10, 1921. Dotted line represents workings platted by pace-and-compass survey.
Gray arkosic conglomerate with abundant pink feldspar and many small pebbles of nearly black argillite.
Arkosic conglomerate overlain by a few feet of coarser conglomerate with pebbles of quartzite and quartz; this grades upward into quartzite.
Country rock of upper tunnel all Tintic quartzite with low northeast dips
Drift, raises, and winzes on Baby McKee fissure, whose average strike and dip are about N.40°E., 50°NW.
Fault
70°
Several tight fissures with a little galena
65°
Fissure shifted about 10' by northwest fault
75°
68°
77°
UPPER TUNNEL
9075'±
N
Country rock in lower tunnel is Tintic quartzite (Є) except where otherwise noted. Low northeasterly dips
LOWER TUNNEL
25°
80°
Quartzite
Shale, lower member of Ophir shale (Є), with steep dips
Fault
Cherty Deseret and Madison limestone, with steep easterly dips
8775'±
EXPLANATION
70°
Fault or fissure showing dip and downthrown side
25°
Strike and dip of beds
Raise
Winze
100
0
500 Feet

Figure 110: HOWELL MINE, UPPER AND LOWER TUNNELS.

Adapted from Calkins and Butler, 1943, plate 34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Fissure shifted 10' by northwest
Several tight fissures with a little galena
Fault
70°
70°
70°
65°
70°
70°
Country rock of upper tunnel all Tintic quartzite with low northeast dips
Drift, raises, and winzes on Baby McKee fissure, whose average strike and dip are about N.40°E, 50°NW
UPPER TUNNEL
9075'±
EXPLANATION
70°
Fault or fissure showing dip and downthrown side
25
Strike and dip of beds
Raise
Winze
100
0
500 Feet

Figure 110: HOWELL MINE, UPPER AND

Adapted from Calkins and Butler, 1943.

The main and upper tunnels are largely in Tintic Quartzite, and follow a zone of sericitization, pyritization, and crystalline quartz associated with the fissures. In outcrop, the Baby McKee fissure is 15 to 80 cm in width, and contains quartz and some pyrite. The main (lower) tunnel passed through the Tintic Quartzite and into the underlying tillite and conglomerate of the Mutual Formation (Calkins and Butler, 1943, p. 109), which now comprise much of the dump of this adit. The northernmost part of the property, prospected from the American Metals level, lies partially east of the West Superior fault, and hence in Paleozoic carbonate rocks. Production from the mine has not been large; it apparently came from steeply dipping shoots in the narrow fissure zone. Minerals noted on the dump include coarse galena, pyrite, sphalerite, chalcopyrite, and secondary carbonates and oxides of lead and copper. The ore potential in areas thus far explored appears to be small.

Cardiff Mine

The Cardiff mine is located on the south side of Mill D South Fork west of Reed and Benson Ridge. The main (600 level) portal is located in SWSESW 30-2S-3E at an elevation of 9,080 feet (2,768m), near the creek bottom. Mineralization was prospected near the head of Mill D South Fork prior to 1900 by the South Fork Consolidated and Jones Mining Companies. Thomas B. Jones, a persistent prospector, began work in the 1880s; in 1902 control of the property fell to Fred W. Price, a native of Cardiff, Wales, who organized the Mountain Chief Mining Company. A shaft was sunk on a persistent mineralized fissure near its junction with the important East Superior fault zone, in a small cirque at the southeast end of Mill D South Fork. In January, 1906, an avalanche smashed the shafthouse and buried the mine horses, leaving four miners to struggle to safety down to the main canyon. The Cardiff Mining and Milling Company was formed to finance a deeper adit, the No. 3 or 300 level, from a safer location. The tunnel, begun in the summer of 1907, encountered a 15-inch (60cm) wide zone of high grade copper-silver ore at about 1,500 feet

(427m) from the portal, in quartzite. Exploration showed that this zone, known as the Cardiff fissure, strikes N. 50-60° E. and dips about 70 degrees north. Small-scale production was begun, reaching 150 tons per month in 1911. A lower adit (600 level) was driven toward the same zone. The existence of thrust faulting was beginning to be recognized in the area; Hintze (1913, p. 138) wrote:

> "The understanding of this relationship is clearly of the utmost importance to the mining people of South Fork, who have never suspected the presence of limestone series below the quartzites..."

In the Fall of 1914, at 2,400 feet (732m) from the portal, the 600 level adit entered a large ore body in crushed limestone at the intersection of the Cardiff fissure and the Alta overthrust fault. A raise above the 600 level followed high grade silver-lead ore, which proved to be the largest yet discovered in the district, averaging 10 feet (3m) in thickness. It followed the plunging intersection of the thrust and the fissure for more than 300 feet (90m) in horizontal plan. Vertical and inclined shafts below the tunnel level developed about 200,000 tons of ore averaging $30 per ton (Calkins and Butler, 1943, p. 110). The mining boom resulting from the discovery led to the driving of many deep developmental adits in the region, and much exploration of the Alta overthrust zone. The Cardiff mine produced as much as 150 tons per day during the summer seasons in the 1917-1924 era. The mine operated year round, obtaining supplies and mail in winter either via the connecting Solumbus-Rexall tunnel from Alta, or occasionally by parachute. The Beefsteak Raise was driven from the main tunnel to the two company boarding houses on the flat above the portal to provide winter access to the workings. Production from the Cardiff between 1910 and 1926 amounted to 108,443 dry short tons averaging 17.73 ounces silver, 8.26 percent zinc, 26.74 percent lead, 0.83 percent copper, and 9.51 percent iron. The net smelter return on this ore was $3,560,115.52.

Stoping was conducted to the 1500 level along the intersection of the Cardiff fissure and the overthrust in various carbonate lithologies. Below the 1500 level the ore reportedly was offset or terminated against faulting (J. H. Beeson, personal communication, 1966). Other ore bodies were later found on the thrust contact at its intersection with other fissures; one of these bodies, the No. 1 vein, 800 feet (244m) south of the main incline, was 5 feet thick and 9 feet wide (1.5 x 2.7m) and was continuous for a horizontal distance of over 200 feet (61m) along the strike of the fissure. Lessees achieved only a small amount of production after the 1920s from workings off the 600 level. The deeper levels were dewatered in 1936-37 and about 20,000 tons of lead and lead-zinc ore were shipped. In the early 1950s, a drift from the Wasatch Drain tunnel (portaled on the Snow Bird claim, now Snowbird resort in Little Cottonwood Canyon) was extended beneath the Cardiff workings. This required nearly a mile of drifting, most of it along or near the overthrust zone. Initially, a small mineralized fissure in quartzite was followed in the area near the old Cardiff stopes, and the work failed to find the downward continuation of the ore body. Work ceased for several years. Diamond drilling from the tunnel level resumed in 1960 and the down-dip portion of the Cardiff ore body was encountered in October, 280 feet (85m) down-dip from the old 1400 level. The best assay from one face of ore ran 37.8 ounces silver per ton, 26.6 percent lead, 5.02 percent copper, and 35.6 percent zinc. One 66.587-ton shipment the following summer yielded a net return of $84.45 per ton and assayed 0.014 ounce gold per ton, 32.1 ounces silver per ton, 4.13 percent copper, 21.3 percent lead, 16.1 percent zinc and 0.95 percent arsenic. The ore body reached a thickness of 9 feet (2.7m) and a width of 12 to 14 feet (3.6-4.3m) at a depth of 27 feet (8m) below the drain tunnel (Eng. & Min. Journal, Sept., 1961). The fissure was variable in width below the drain tunnel, and was confined to quartzite; very little bedded replacement ore was observed. The ore bottomed against a post-mineral fault. A total production, valued between $500,000 and $600,000, was achieved from the Cardiff workings on and below the Wasatch Drain tunnel level.

In 1966 exploration was being conducted adjacent to fissures a few hundred feet (30-80m) north-northeast of the Cardiff, apparently in Kennebec ground. A working face had cut a narrow fissure containing lead, zinc, and copper mineralization. Fifty feet (15m) to the southwest a 25-foot (7.5m) raise and a short drift yielded small tonnages of ore. The mining lease was terminated during a smelter strike late in 1967 and no work has been conducted in the mine since.

Surface rocks on the productive portion of the Cardiff ground, east of the East Superior fault, are Tintic Quartzite and Ophir Shale. To the west, in the upthrown block between the Superior faults, the limestones of the lower plate of the thrust are exposed. The 600 level exposes Deseret Limestone, which yielded most of the production, and older formations beneath the thrust. Calkins and Butler (1943, plate 35) provide more detail regarding ore control. Ore from above the lower tunnel apparently occurred as lenses partially replacing beds in quartzite, and as fillings in the adjacent Cardiff fissure. The ore deposit was thus an irregular replacement body in limestone, sandwiched between the less productive Tintic Quartzite and fissure zones. Major sulfide minerals in the ore were galena, sphalerite, and tetrahedrite in varying proportions. The oxidized ore from the main workings consisted of cerussite and "limonite" plus plumbojarosite and residual galena. The potential for further ore in the mine is not known. J. J. Beeson (personal communication from the last operator of the mine, 1968), believes there is untested potential in the overthrust zone on the Wasatch Drain tunnel level. Heyl (1963, p. B-6) reports:

> "Oxidized zinc ore is abundant in the upper levels of the Cardiff mine, especially in the western part near the edges of the deposit. This is mostly smithsonite that contains manganese, iron, and copper, in such quantities that it has been difficult to fume economically using present (1952) methods."

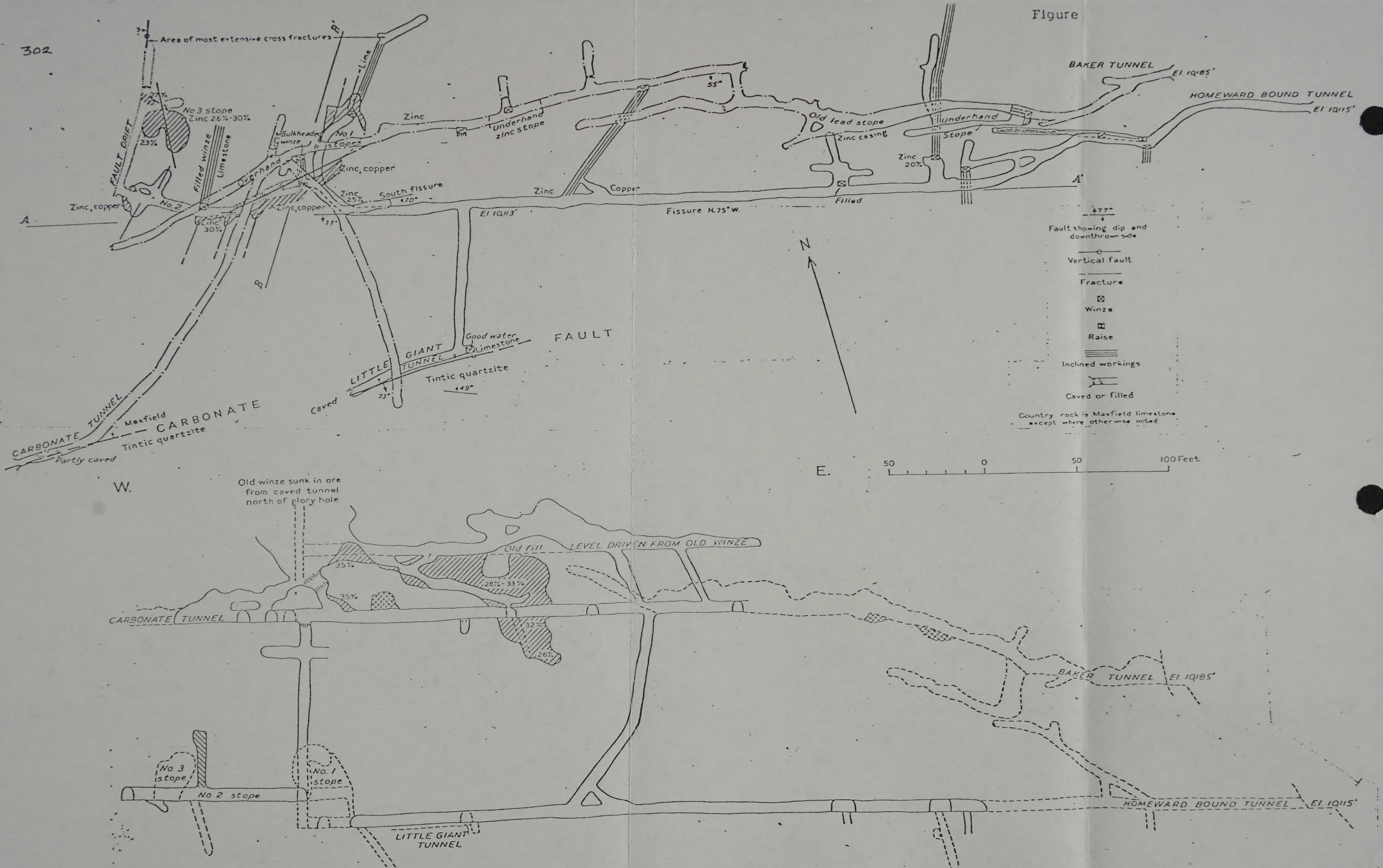
Oxide ore production ceased in 1951, when smelters refused to purchase such ores (U. S. Bur. Mines Mineral Yearbook, 1951). A small tonnage of sulfide zinc ore is believed to have been left unmined in the lower levels of the mine.

Carbonate Mine

The Carbonate mine is approximately 2,500 feet (762m) east-southeast of the Silver Mountain mine between Mineral Fork and Mill D South Fork. It is located in unsurveyed SWSESE 24-2S-2E with the main portal at and elevation of 9,960 feet (3,030m); the workings lie just south of Carbonate peak, south of Kessler Peak. Production of lead-silver ore from the mine was considerable in early years, ore shipped during 1878 had a grade of 55 to 65 percent lead and 50 to 60 ounces of silver to the ton. Later shipments were of lower grades of lead and silver, but zinc was an important constituent (Calkins and Butler, 1943, p. 105). Access to the workings is by several adits and shallow shafts. The two main levels, the upper Carbonate tunnel level and the lower Homeward Bound tunnel level, are approximately 110 feet (34m) apart (figure 111). Several raises connect the two levels; total length of workings is about 1,800 feet (549m). The workings are now inaccessible. The earliest discovery was on the Provo claim, located in November, 1870, reportedly on a 24-foot (7m) vein. By 1872, 200 tons of oxidized ore had been extracted from a 120-foot (37m) incline (Murphy, 1872) by a New York company. A few years later lessees, hand-picking the Provo dump, discovered the main ore body. Major production was achieved in 1877-78, and much of the ore was shipped to the Carbonate Company's charcoal-fired smelter near Hilliard, Wyoming. The ore yielded 1,445 ounces of gold, 333,661 ounces of silver and 4,288,933 pounds of lead. According to the Engineerin and Mining Journal of January 11, 1879, p. 30-31, the main Carbonate stope of the mine was 60 feet x 20 feet x 26 feet high (18 x 6 x 8m) and had yielded 4,208 tons of ore that had an average value of $61 per ton and assayed 55-65 percent lead and 50-60 ounces of silver per ton. Stopes on the Sailor Jack fissures, being worked from the Baker tunnel, had yielded an additional $100,000. The Cave stope, connected by drift with the Carbonate stope, measured 30 feet x 10 feet x 9 feet high (9 x 3 x 3m) and yielded 400 tons. The discovery glory hole, on the west side of the ridge, 250 feet (76m) below the crest, revealed an ore body 28 feet

302

Figure



PROJECTION ON VERTICAL PLANE THROUGH LINE A-A'

Adapted from Calkins and Butler, 1943, plate 32

Figure III: PLAN AND SECTION OF CARBONATE MINE.
After C. E. Ryan.

(8m) wide. Huntley (1880, p. 430) noted that the largest body was lenticular in shape, and had dimensions of 200 x 100 x 50 feet (61 x 30 x 15m). It was timbered with 365 square sets. The mine was worked intermittently and for small tonnages from 1884 to 1910. Production between 1913 and 1916 totaled 658 tons, most of it averaging 23.6 percent recoverable zinc.

Transportation to and from the mine was at first via two trails, one from Argenta extending up the north and northwestern slope of Kessler Peak, and the other from Mill D South Fork. Shipments were sent down these trails on cowhides, often on a coating of ice. About 1911, a "jig-back" aerial tramway was erected using two counterbalancing buckets and utilizing a continuous cable passing over a wooden drum. In 1914-1916 the last ore, consisting of a small tonnage, was mined from the Carbonate Group. The Carbonate mine is localized in a block of spotted, mottled Lower Cambrian limestone (Reed and Benson Member of the Ophir Shale) adjacent to the Tintic Quartzite on the south, east, and west. A branch of the Alta overthrust crops out south of the deposit. Minerals noted at the mine include galena, cuprite, azurite, malachite, aurichalcite, smithsonite, cerussite, and brown limonite rich in zinc. Iron oxides are abundant, but quartz was apparently not common in the ore. A possible small resource of gallium is indicated (James, in preparation, 1977). A grab sample from boulders of goethite and oxidized lead and zinc minerals from the dumps of the Little Giant and Carbonate adits, on the west side of Carbonate Peak, contained 0.019 to 0.020 percent gallium and less than 0.001 percent germanium. A sample of oxide copper-zinc-lead ore from the Homeward Bound dump contained only 0.0067 percent gallium and no germanium.

Reed and Benson (Kennebec) Mine

The old Reed and Benson mine is high on the west side of Mill D South Fork (Cardiff Fork), just north of Flagstaff Mountain. It was later included in the Kennebec Consolidated group of claims, and was explored through deeper adits, including the Kennebec, Cardiff, and Wasatch Drain tunnels. Most of the production apparently came from an adit and shafts in NWSENE 31-2S-3E, high on Reed and Benson Ridge, at an elevation of about 10,070 feet (3,070m). Mineralization was discovered in August, 1870, and by the summer of 1873 the mine was producing 10 tons per day (Utah Mining Gazette, various issues). Ore was lowered to the wagon road in Mill D South Fork via a 45 degree rail tramway, utilizing two cars connected by a cable passing over a huge drum at the mine portal. The 1582-foot tramway was described as probably being the costliest and most perfect ever built in the U. S. A series of four irregular inclines followed the ore downward, and a depth of 600 feet had been reached by 1874. The ore was described as being very ferruginous, containing about 25 percent lead and over 50 ounces silver per ton (Raymond, 1874). By 1880 the mine was opened 1100 feet (335m) dow the 35 degree dip by a series of irregular inclines following the ore chimney. Near the surface the ore extended 100 feet (30m) in a horizontal direction, but its dimensions decreased with depth (Huntley, 1884). The difficulties associated with hoisting ore up four inclines with windlasses, and then up a final shaft with an underground (horse-powered) whim hoist, soon led to plans for a deeper adit. In 1875 a long tunnel was begun at an elevation of about 9,170 feet (2,795m) to pass beneath the old workings. It was driven more than 3,000 feet southeasterly but failed to find a downward continuation for the ore. An intermediate level, the Craig tunnel, was driven just beneath the old incline and it, too, failed to find ore. Thousands of feet of workings were driven along the Alta overthrust from the 800 level of the Cardiff mine in 1919-1923, in Kennebec ground (Calkins and Butler, 1943, p. 109). Still deeper exploration from the Wasatch Drain tunnel-Cardiff drift led to the mining of small quantities of high-grade lead-zinc-silver sulfide ore (figure 112).

Several smaller oxidized base metal deposits were explored on or adjacent to the Kennebec property. The Ophir, a parallel claim to the southwest, was operated steadily from 1870 to 1880. The adjacent Sampson claim, high on

MAP OF REED & BENSON, AND CRAIG TUNNELS, KENNEBEC CONSOLIDATED MINING CO.

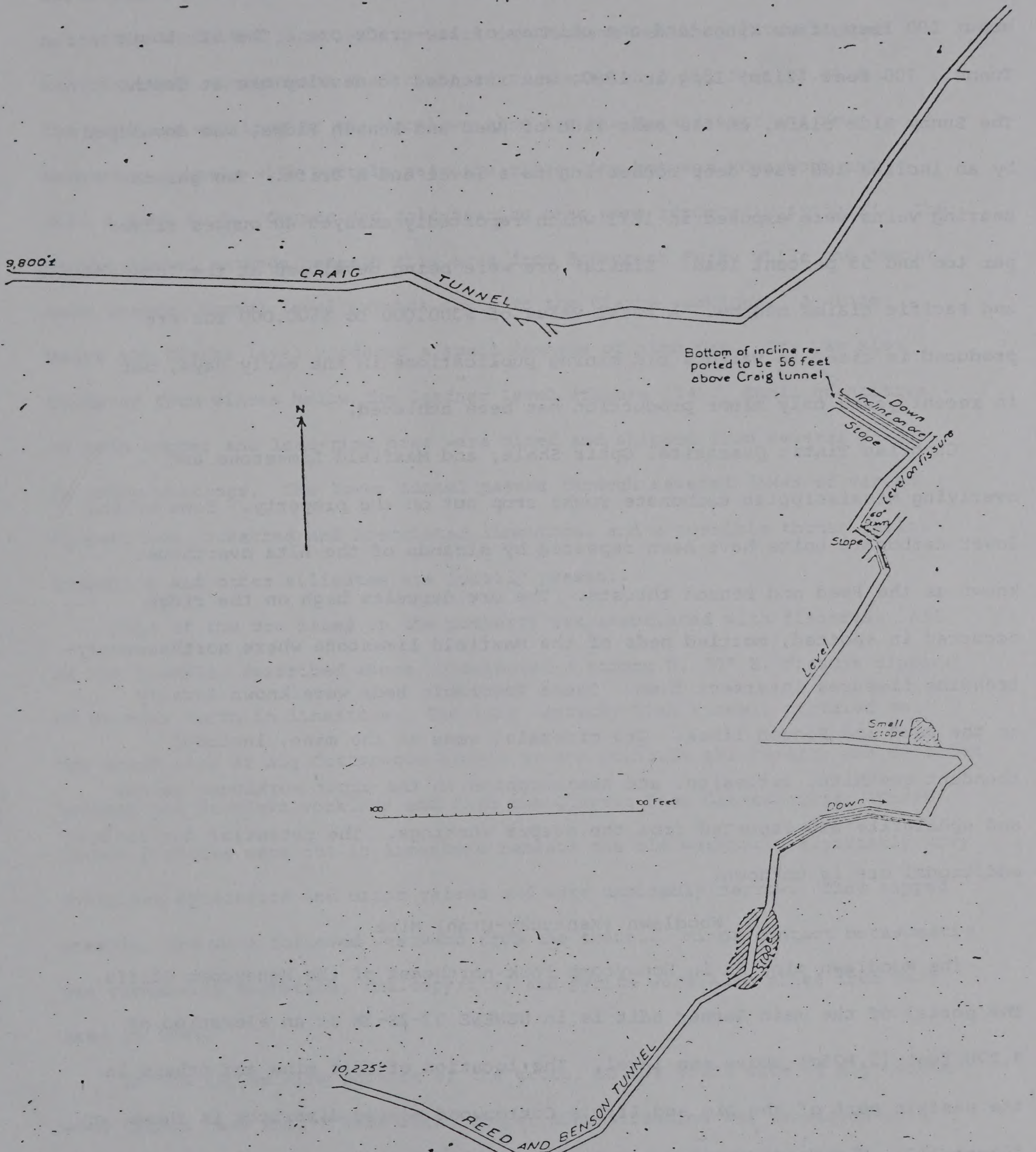


Figure 112: Kennebec Consolidated Mining Co., Reed & Benson, and Craig tunnels and workings.

Adapted from Calkins and Butler, 1943, p. 108

the ridge, was developed by a shaft following a zone of iron oxides and had about 500 feet of workings and one chimney of low-grade ore. The St. Louis Tunnel, 700 feet (213m) long in 1880, was intended to develop ore at depth. The Sunny Side claim, on the east side of Reed and Benson Ridge, was developed by an incline 108 feet deep connecting to a level and a drift. Two galena-bearing veins were exposed in 1873 which reportedly assayed 40 ounces silver per ton and 55 percent lead. Similar ore were being developed at the Independence and Pacific claims nearby. A total value of $300,000 to $500,000 for ore produced is cited in various old mining publications in the early days, but in recent years only minor production has been achieved.

Cambrian Tintic Quartzite, Ophir Shale, and Maxfield Limestone and overlying Mississippian carbonate rocks crop out on the property. Some of the lower carbonate units have been repeated by strands of the Alta overthrust known as the Reed and Benson thrusts. The ore deposits high on the ridge occurred in spotted, mottled beds of the Maxfield Limestone where northeasterly-trending fissures intersect them. These favorable beds were known locally as the Reed and Benson limes. Ore minerals, seen at the mine, included abundant goethite, cerussite, and hemimorphite in the upper workings; galena and sphalerite are reported from the deeper workings. The potential for finding additional ore is unknown.

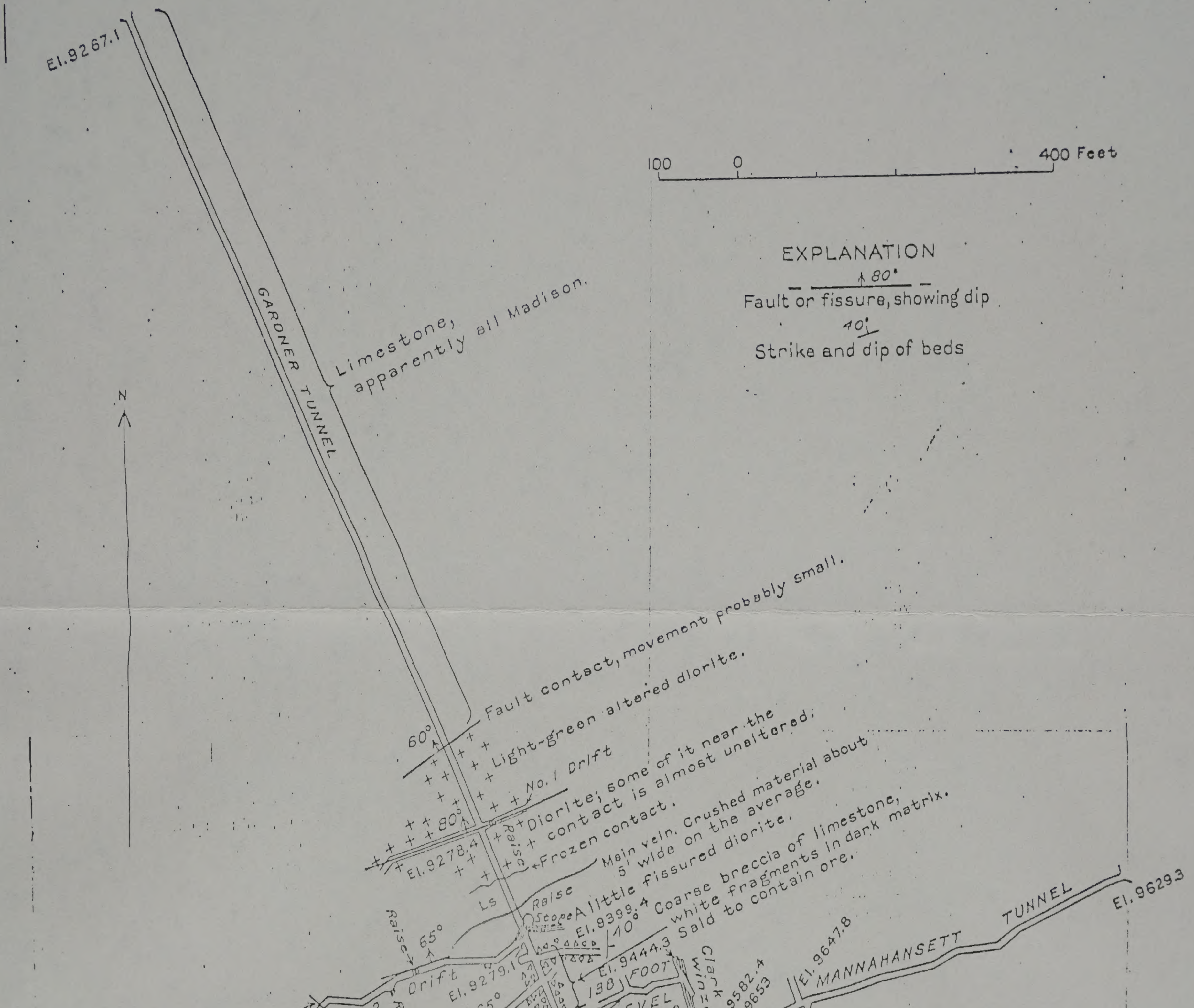
Woodlawn (Kentucky-Utah) Mine

The Woodlawn mine is in Honeycomb Fork northeast of the Honeycomb Cliffs. The portal of the main Garner adit is in NENENE 33-2S-3E at an elevation of 9,270 feet (2,825m) above sea level. The location of this mine and others in the eastern part of the Big and Little Cottonwood mining districts is shown on figure 113. The Woodlawn mine was later consolidated with nearby properties to form the Kentucky-Utah Company; these additional properties are also discussed. At the time of consolidation, in 1928, the total production was reportedly valued at $30,000. The first discovery of ore was made prior to 1900 and significant production was achieved about 1904; the mine was worked intermittently until the late 1920s. Later development was through the deeper Kentucky-Utah (Cottonwood Coalition) adit, elevation 8,160 feet (2,487m). The earliest workings of the Woodlawn mine are the Manahansett and New Sensation tunnels with portals near the ridge-line between Honeycomb and Mill F East Fork. Copper and gold-bearing ores were reportedly produced. The Clarke tunnel extends beneath this area from Honeycomb Fork, while the deeper, main Gardner tunnel level extends south to the Clarke workings. A winze below the Clarke level produced a small tonnage of zinc ore. Ore was also produced from winzes below the Gardner level (figure 114). Small quantities of both copper and lead-zinc ores were mined and shipped from several places in these workings. The lower tunnel passes through several dikes of varied composition, bleached and brecciated limestone, and a possible thrust fault. Tremolite and other silicates are locally present.

Most of the ore mined on the property was associated with fissures. All of the tunnels, described above, prospected a strong N. 70° E. fissure dipping 60 degrees north in limestone. The long Kentucky-Utah tunnel, portaled on the south side of Big Cottonwood Canyon at the Solitude ski resort, was extended beneath the Woodlawn workings and into the Clayton Peak Granodiorite. Three narrow fissures were cut in limestone beneath the old workings; reportedly they contained sphalerite and minor galena and were unminably narrow. They dipped steeply, and were followed westward from the tunnel. Minor contact metasomatic ore containing magnetite, chalcopyrite, and pyrite were also mined from this area in 1941.

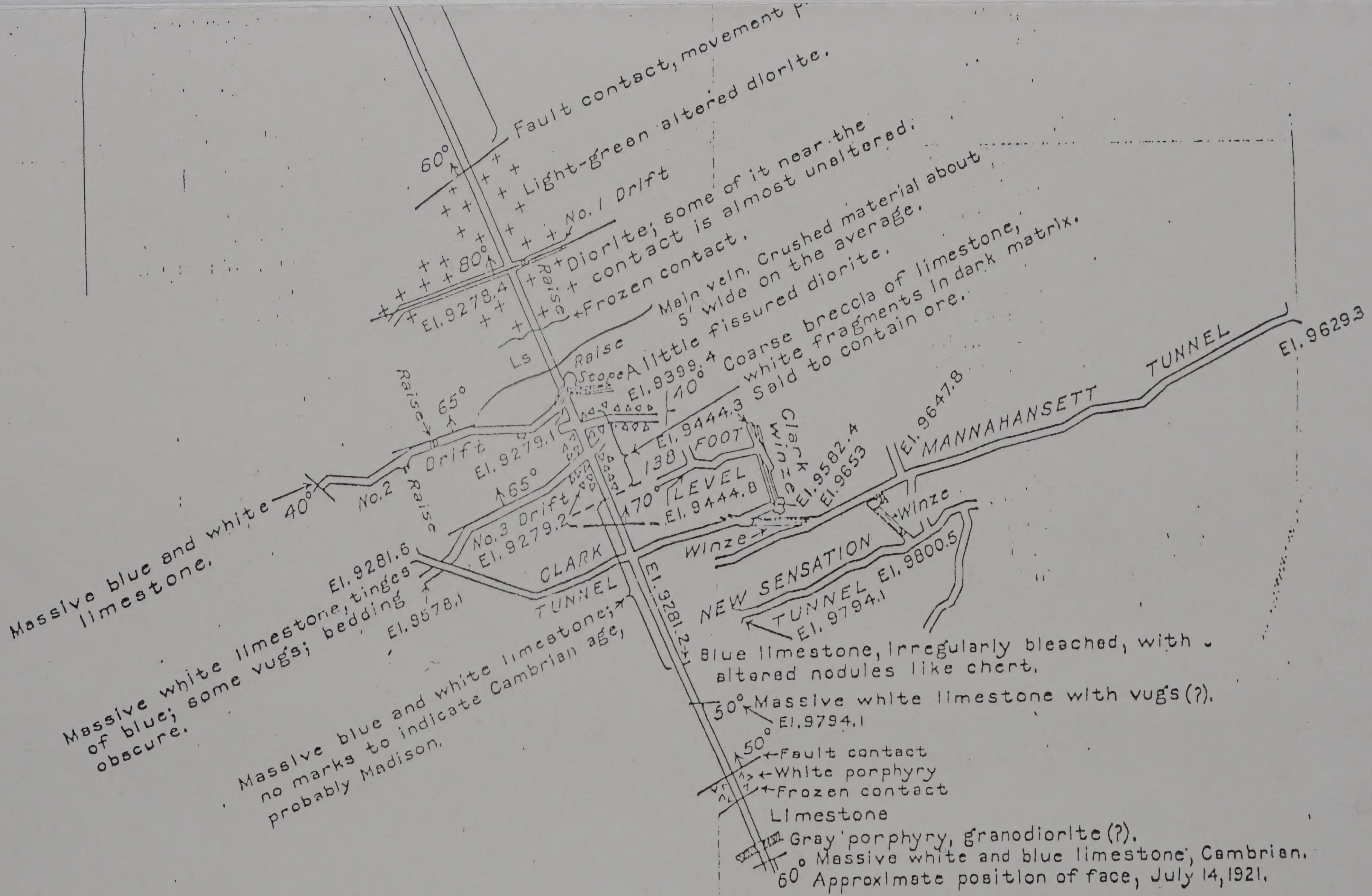
In the Copper King portion of the group, on the south side of Big Cottonwood Canyon near Mill F East Fork, copper mineralization was developed by a tunnel, an incline, and winzes. Calkins and Butler (1943, p. 111-112) observed ore in fissures and in minor bedded replacement zones in the Deseret Limestone. Minor calc-silicate minerals were noted at the surface. A body of granodiorite,

Figure 114:
MAB OF WOODLAWN MINE


El. 9267.1
GARDONER TUNNEL
Limestone, apparently all Madison.
N
100 0 400 Feet
EXPLANATION
80°
Fault or fissure, showing dip
40°
Strike and dip of beds
Fault contact, movement probably small.
60°
Light-green altered diorite.
No. 1 Drift
Diorite; some of it near the contact is almost unaltered.
80°
El. 9278.4
Raise
Frozen contact.
Main vein. Crushed material about 5' wide on the average.
Ls
Raise
Stope
A little fissured diorite.
El. 9399.4
40°
Coarse breccia of limestone, white fragments in dark matrix. Said to contain ore.
Raise
65°
Drift
El. 9279.1
El. 9444.3
138 FOOT LEVEL
El. 9444.8
Clark Winze
El. 9582.4
El. 9653
El. 9647.8
MANNAHANSETT TUNNEL
El. 96293
Massive blue and white limestone.
40°
No. 2
Raise
65°
No. 3 Drift
El. 9279.2
70°
Winze
Winze
CLARK TUNNEL
El. 9281.6
Massive white limestone, tinges of blue; some vugs; bedding obscure.
El. 9578.1
Massive blue and white limestone; no marks to indicate Cambrian age, probably Madison.
El. 9281.2
NEW SENSATION TUNNEL
El. 9800.5
El. 9794.1
Blue limestone, irregularly bleached, with altered nodules like chert.
50°
Massive white limestone with vugs (?).
El. 9794.1
50°
Fault contact
White porphyry
Frozen contact
Limestone
Gray porphyry, granodiorite (?).
Massive white and blue limestone, Cambrian.
60°
Approximate position of face, July 14, 1921.

WORKINGS OF WOODLAWN MINE.

Adapted from Calkins and Butler, 1943, plate 36


Fault contact, movement p
60°
Light-green altered diorite.
No. 1 Drift
Diorite; some of it near the contact is almost unaltered.
80°
Frozen contact.
El. 9278.4
Raise
Main vein. Crushed material about 5' wide on the average.
A little fissured diorite.
Ls
Raise
Stope
El. 9399.4
40°
Coarse breccia of limestone, white fragments in dark matrix. Said to contain ore.
Raise
65°
Drift
El. 9279.1
El. 9444.3
138 FOOT LEVEL
Clark Winze
El. 9582.4
El. 9653
El. 9647.8
MANNAHANSETT TUNNEL
El. 96293
No. 2
Raise
40°
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El. 9279.2
70°
El. 9444.8
Massive blue and white limestone.
El. 9281.6
Massive white limestone, tinges of blue; some vugs; bedding obscure.
El. 9578.1
CLARK TUNNEL
Winze
Winze
NEW SENSATION TUNNEL
El. 9800.5
El. 9794.1
El. 9281.2
Massive blue and white limestone; no marks to indicate Cambrian age, probably Madison.
Blue limestone, irregularly bleached, with altered nodules like chert.
50° Massive white limestone with vugs (?).
El. 9794.1
50°
Fault contact
White porphyry
Frozen contact
Limestone
Gray porphyry, granodiorite (?).
Massive white and blue limestone, Cambrian.
60° Approximate position of face, July 14, 1921.

WORKINGS OF WOODLAWN MINE.

Adapted from Calkins and Butler, 1943, plate 36

similar to the Clayton Peak stock, is exposed about 3,000 feet (914m) to the southeast, and may be nearer to the prospect area beneath alluvial cover. Several dikes are present underground.

The Kentucky-Utah (Big Cottonwood Coalition) adit passed beneath this area. A winze was sunk 25 feet (8m) on a small bismuth-bearing body of high-grade lead ore 4,800 feet (1,463m) from the portal and a raise was used to stope the ore. Neither yielded a large ore body. About 5,600 feet (1,707m) from the portal (about 1,000 feet south of the surface workings) a northeast striking fissure was cut containing silver-lead ore a few inches to four feet in width. The fissure was followed to the northeast, but only minor ore production was achieved.

To the west the Queen Bess claim contains a northeasterly trending fissure that appears to be associated with a dike. Development is by a small adit and shaft cut in the Humbug Formation. A small production of lead-silver ore was reported, 1907-1909. Extensive prospecting has tested a variety of possible ore environments on Kentucky-Utah ground. Potential for further discovery and subsequent ore production is considered small.

Prince of Wales and Antelope Group

This group of mines is located near the head of Silver Fork Canyon just west of the Honeycomb Cliffs and northeast of Davenport Hill. The collar of the Prince of Wales shaft is in NWSWNE 33-2S-3E at an elevation of 9,875 feet (3,010m). The Antelope and Prince of Wales group of mines were among the early producers in the districts after mineralization was discovered in 1870. The Prince of Wales inclined shaft was dug 900 feet (274m) deep and followed the Prince fissure down. The nearby Highland Chief shaft connected with the Prince workings (figure 115). In 1875 the Prince produced 2,000 tons of ore assaying 135 ounces in silver and 35 percent lead (Raymond, 1875). A decline in prices, caving ground, and water at depth led to the closing of operations by the 1880s. Lessees intermittently worked the properties until 1910. The

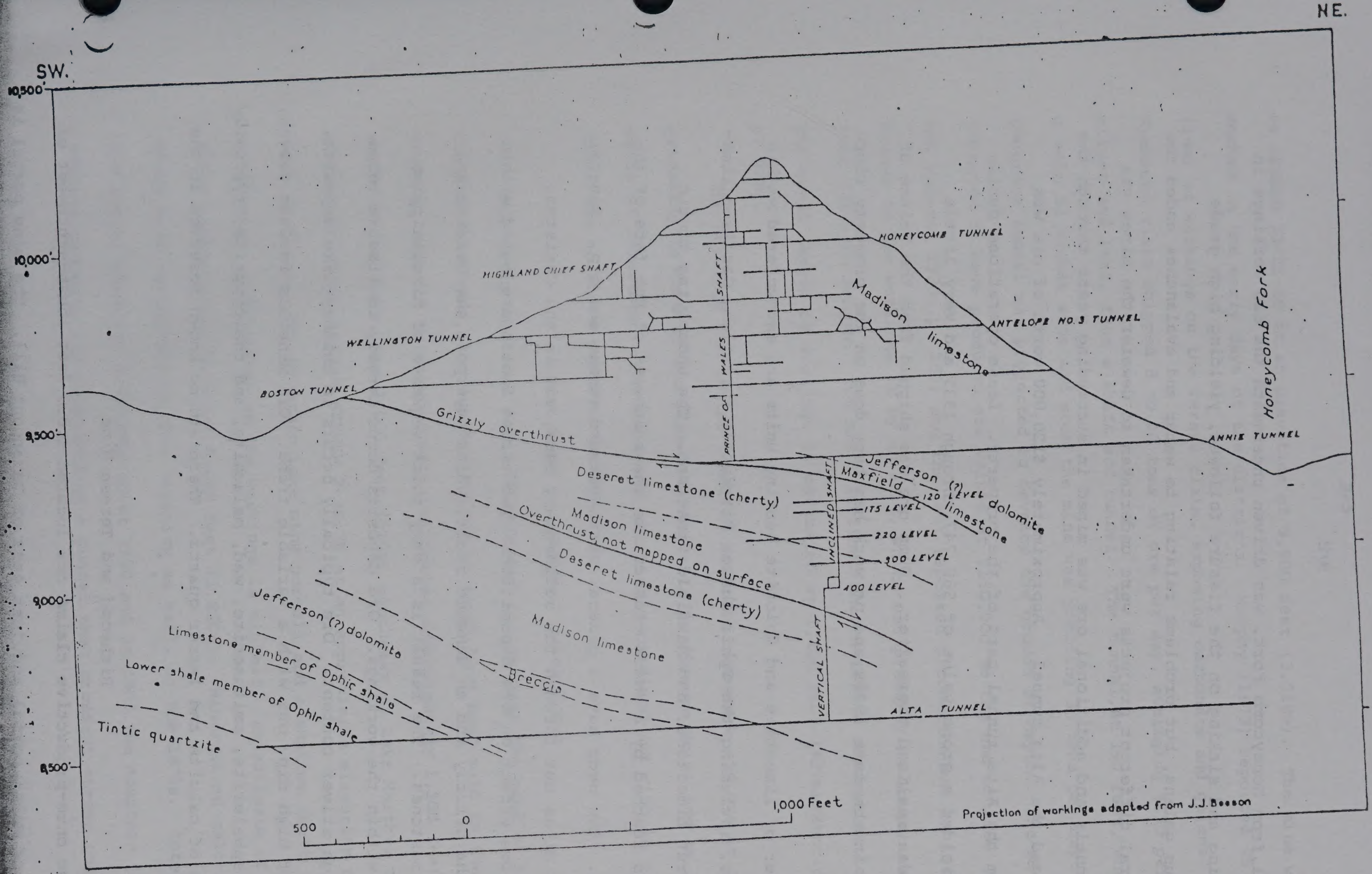


Figure: 115 Cross-section of the Prince of Wales mine.
Source: Calkins and Butler, 1943, plate 37.

Annie tunnel, from Honeycomb Fork, was driven underneath the old workings in 1916. Raising and sinking on the fissure followed, yielding high grade argentiferous galena, but problems relating to water and avalanches ended the work. Several different projects were undertaken to dewater the mines via drainage tunnels and additional ore was mined in succeeding years through the Quad drift and the Alta tunnel. Approximately $120,000 worth of ore was shipped from the Alta tunnel part of the property. Lease operations during the 1930s yielded a gross value of $66,747 through 1935 and very little production was realized thereafter. Dump ore was shipped from the Prince of Wales shaft in the late 1930s and no work has been done on the property since that time.

A number of limestone and dolomite bearing units are encountered within the workings, including the Ophir Shale, Fitchville Formation, Gardison Limestone, Deseret Limestone, and Maxfield Limestone. The underlying Tintic Quartzite is reached by a short crosscut to the southwest of the face of the Alta tunnel. The beds have a general northwestward strike and dip. Several lamprophyre dikes cut through the sedimentary beds, and in the Christmas stope had some effect on ore deposition. Two thrust faults are noted within the mine, the Grizzly and an unnamed fault, which superpose the Deseret and Gardison Limestones. The result is a very thick sequence of Mississippian limestones within the workings. Ore deposits occur largely in fissure veins having a high silver content. Ore typically occurs in chimney-like deposits, generally of high dip, but with a variable trend. Ore minerals include galena, cerussite, sphalerite, smithsonite, wad, malachite, and chalcopyrite, typically in a gangue of calcite and lesser quartz. There are no known reserves in the mines.

Richmond and Teresa Mine

The two once-productive claims are located 1,000 feet south-southwest of the Prince of Wales portal and just east of Davenport Hill. The mine portal is in SESENW 33-2S-3E at an elevation of 9,900 feet (3,018m). The mine was worked in the early days of the districts. Murphy (1872) reported 45 feet (14m) of workings on the Teresa claim, exposing carbonate and galena. The Richmond claim shipped 8 to 10 tons of ore per day, averaging $115 per ton in silver and lead, from a shaft and tunnel. The tunnel,at 190 feet, encountered a vein 52 inches wide and soon the mine was yielding 30 tons per day. The Congress tunnel was projected to develop the ground at depth. The mine is reported to have produced ore valued at $150,000 to the end of 1880 (Butler and others, 1920, p. 257) and the last reported production was in 1887. Access to the workings is by an adit, which was probably no longer than 250 feet (76m) in length. Two small inclined shafts follow mineralization downward. The total length of workings is estimated at 1,400 feet (427m)(Huntley, 1885, p. 429).

The workings are in the Cambrian Maxfield Limestone and ore is found primarily in tabular and pipe-like deposits in fissure veins and as replacements of limestone. The ore mined was highly oxidized and rich in silver. There are no known reserves in the mine.

Great Western (Mountain Lake) Group

This group includes about 98 patented claims near the head of Big Cottonwood Canyon, the surface rights of which have been sold to the National Forest. The Big Cottonwood mine is located approximately 1,500 feet (450m) south of Dog Lake, and 2,000 feet (610m) southeast of Lake Martha, and the portal is in unsurveyed SENWSW 2-3S-3E at an approximate elevation of 9,620 feet (2,930m). The Mountain Lake mine portals and a shallow shaft lie to the southeast. Information on the workings is minimal. An estimate of the total length would be about 6,000 feet (1,830m). Mineralized calc-silicate rocks were recognized in this vicinity as early as the 1870s. Interest in the copper showings developed about 1900 and in 1903 the Mountain Lake-Great Western property was developed by a tunnel that crosscut strong copper mineralization 700 feet from the portal. By 1907 the Steamboat tunnel, driven from the Snake Creek side of the divide, was 3,500 feet (1,067m) long. The tunnel cuts 1,000 feet (300m) of Clayton Peak "diorite" and 2,000 feet (610m) of granodiorite, and minor mineralization (Calkins and Butler, 1943, p. 113). By 1908 the Mountain Lake portion of the property had shipped several carloads of "carbonate" ore which had been followed downward for 300 feet (91m) on an incline. None of these workings are now accessible. The adjacent Big Cottonwood mine workings, then under separate ownership, prospected similar rocks.

The ore deposits are localized at and near the contact of carbonate rocks (Gardison, Deseret and Humbug Formations) with the Alta and Clayton Peak stocks. Copper, lead, and minor gold and tungsten values have been of interest in the past. The massive bodies of magnetite containing these metals may be of interest as iron ores. Their geometry, in prospects and at the surface, is very irregular; thick continuous bodies appear to be uncommon. Ore minerals include bornite, chalcocite, pyrite, chalcopyrite, malachite, minor galena and scheelite. A wide variety of unusual calc-silicates, including ludwigite, magnesioludwigite, forsterite, and a brittle mica, have been identified on the property. The ore potential for this area is unknown and for lead and zinc should be minimal.

Silver King Mines Group

This group covers a large area of patented claims on Scott Hill including the Iowa Copper tunnel, Copper Apex or Scott mine, the Scottish Chief (Insley) mine, Elgin mine, and the American tunnel. The portal of the Iowa Copper tunnel is in NWSWNW 25-2S-3E at an elevation of 9,000 feet (2,743m) above sea level. The mine is reached by a steep jeep trail on the east side of Mill F East Fork. Ore was found cropping out in the early 1870s as prospectors worked eastward from discoveries on the divide, north of Alta. By September, 1873, the Elgin mine had 1,140 feet (347m) of workings, but little ore was shipped prior to 1895. The property consists of many old claim groups, some, like the Barry-Coxe mine, lie on the Park City side of the drainage divide. The properties were consolidated in 1927 by stockholders of the Silver King Coalition mine in Park City, who sought a possible extension of the rich bedded deposits of that district. The Iowa Copper tunnel, begun in 1908, was extended northward into Scott Hill. Small bodies of both lead and copper ore were developed and the mine produced 671 tons in 1917. Some production is said to have come from a drift from an underground inclined shaft. The Scottish Chief (Insley) property was developed by an irregular incline following a locally mineralized zone down-dip in the vicinity of several small leucocratic dikes. From 1895 to 1900 several hundred tons of ore averaging 30 percent lead, 25 ounces silver, and $0.15 gold to the ton were shipped and in 1902, 40 tons of ore from a crosscut from the incline reportedly assayed 26 percent lead, 18 ounces silver, $2.60 gold to the ton, and 3.5 percent copper. The Colorado Boy adit was driven from the northwest slope of Scott Hill intending to connect with the bottom of the Scottish Chief incline. Total workings in 1909 wer 1600 feet (488m) of inclines and 1,400 feet (427m) of drifting. Work ceased about 1910. The American tunnel was driven 500 feet (152m) and cut several beds showing copper. In the early 1930s the long Spiro (King Consolidated) tunnel was extended from Park City beneath the down-dip extension of the prospects on Silver King ground. A 102-foot (31m) raise and minor crosscuts failed to find commercial ore. Bad ground and ventilation difficulties prevented a complete evaluation of this area. The Copper Apex (Scott, Crystal-Elgin) part of the group is developed by adits and inclines on an east-trending fissure system. Minor production of lead-zinc ore associated with calc-silicate minerals was made in the early 1950s. Total workings of the group exceeds 1 mile (1.6km).

Rock formations exposed on the property include the Triassic Thaynes Formation and Woodside Shale, the Permian Park City Formation and the Permo-Pennsylvanian Weber Quartzite, which all strike northwest and dip northeasterly toward the

Park City district. Deeper sedimentary units are masked by moraine and alluvium. On the south, the porphyritic phase of the Alta stock and small bodies of the Clayton Peak Granodiorite are exposed. Aphanitic to fine-grained dikes, presumably related to these bodies, are exposed in mine workings and surface cuts at several places on the property. Ore minerals and small bodies of calc-silicates occur near these dikes in several localities. Ore minerals noted on old dumps include galena, sphalerite, chalcopyrite, and various oxides and carbonates of copper and lead. Boutwell (1912) noted minor massicot and possible pyromorphite and native silver in the Scottish Chief workings. Ore production has come from fissures, many of them trending northeasterly. Calkins and Butler (1943, p. 113) noted bedded replacement ore adjacent to a fissure mined in a northerly crosscut in the Iowa Copper tunnel. The rock units present on the properties are similar or identical to those which have been highly productive in the Silver King Coalition mine and other large producers of the Park City district. The generally high copper content, the local presence of calc-silicate minerals, and the proximity to large igneous bodies are not identical to geologic conditions in much of the Park City district. The potential for finding additional ore on this property remains unknown.

Eclipse Mine

The Eclipse mine is east-northeast of Flagstaff Mountain near the head of Days Fork. It is approximately 2,500 feet east-southeast of the Reed and Benson mine in NWSENE 32-2S-3E at an elevation of 9,630 feet (2,935m). Apparently ore was discovered about 1880 and in 1881 the main shaft was being sunk in Days Fork. These ore bodies were an extension of the Flagstaff-Emma zone in Little Cottonwood Canyon, held under separate ownership, and work was first conducted through the Flagstaff shaft. Production and operation apparently ceased when the hoisting works burned, prior to or about 1893. The total amount or value of ore produced is unknown.

The workings are developed by means of a vertical shaft, now caved, with at least four levels extending southeasterly. Total length of the workings is probably less than 3,000 feet (914m) including connections to the Flagstaff inclined shaft. Ore deposits were found in the Gardison and Fitchville Formations, as replacements of favorable beds. Some fissure deposits are also present. Ore minerals noted on the dump include galena, cerussite, smithsonite, goethite, and minor copper carbonates. The potential for additional ore is unknown.

Flagstaff Mine

The Flagstaff mine is located on the north side of Little Cottonwood Canyon and the shaft collar is in NWSESW 32-2S-3E at an elevation of 9,570 feet (2,917m). Flagstaff mineralization was discovered in 1869 and mining began shortly thereafter. Huntley (1880) states that the mine produced about 100,000 tons of ore of which 30,000 tons had an average grade of $10 gold, 60 ounces silver, 40 percent lead, and was worth $80 per ton at the time of production. The remaining 70,000 tons had a value of $4 gold, 30 ounces silver, and 20 percent lead valued at $30 per ton at the time of production. Workings of the Flagstaff mine consist of the Flagstaff tunnel, a 900-foot (274m) internal inclined shaft from which several levels were turned, the Tom Moore tunnel and the Burnswood tunnel.

The ore deposits of the Flagstaff were formed as replacements of limestone along fissures. Prospecting was confined to a narrow zone parallel to the bedding in the Mississippian Madison Limestone (Gardison-Fitchville). Minerals reported in the mine are galena, cerussite, plumbojarosite, wulfenite, barite, pyrite, and limonite. Several thousand tons of lead and zinc oxide ores probably remain in the mine (L. P. James, 1977, oral communication).

Emma Mine

The Emma mine, owned by Alta United Mines Company, has changed hands several times in its history. The mine is located on the north side of Little Cottonwood Canyon and the portal of the Bay City tunnel is in SWNENE

5-3S-3W at an elevation of 8,775 feet (2,674m). The Emma claim was located in December, 1868, by F. B. Woodman and the Emma ore body was discovered in a shaft sunk on an iron-stained, altered limestone the following year. In 1870 the Walker brothers purchased an interest in the mine and by the end of the year 5,293 tons of ore had been shipped returning a net value of $125 a ton. Early in 1871 a half interest in the mine was sold to T. W. Park and H. H. Baxter for $375,000 and an additional 1/16 interest was optioned to the two men for approximately $100,000. Between April 25 and September 1, 1871, the owners extracted an additional 5,638 tons from which a net profit of 158,268 British pounds was realized, forcing production to the utmost. This ore was sold in Great Britain and the profits enabled promoters to float a sale of the mine to a British company. On June 11, 1872, Clarence King, geologist for the U. S. Geological Survey, indicated that not over 280 tons of ore remained in reserve and that the ore body terminated at the Montezuma fault in a letter to the secretary of the British company. The event created an international scandal because an American foreign minister had participated in the sale. Between 1873 and 1879 much low-grade ore was mined and concentrated by jigs and in 1876 the 1700-foot (518m) Bay City tunnel was completed at a cost of $75,000. A connection was made with the lowest workings of the mine and a shaft was sunk more than 300 feet (91m) below the level of the Bay City tunnel. Three levels were cut from the shaft at 119, 208, and 283 feet (36, 63, and 86m) and an attempt was made to sink the shaft deeper, however, large amounts of water were encountered along with financial difficulties. The mine was closed and the workings were allowed to flood. Little work was done on the property for the next thirty years, with the exception of an occasional lessee who gouged out small quantities of ore from the upper workings. A new consolidation of the property was made and in August, 1916, drilling was started to look for the faulted part of the Emma ore body. Drilling was done from the Bay City tunnel and on the fourth hole the ore extension was intersected at a depth of 208 feet

(63m) showing a thickness of about 30 feet (9m). Three additional holes were put down proving at least a 150-foot (46m) extension of ore on the other side of the Montezuma fault (figure 116). Through August of 1918 a total production of 10,362.55 tons of ore was realized from which the net smelter returns were $273,742.05, or an average of $26.41 per ton. The ore body was mined until 1919, when it was terminated by a second fault. J. J. Beeson (1919, p. 17) estimated the total output of the mine to the end of 1918 had a value of $3,825,000. The mine workings consist of the original shaft, Emma Hill tunnel, and the Bay City tunnel. Total workings have a length of about 3,500 feet (1,069m).

Several companies tried to work parts of the 91 acres which lie between the Emma and Flagstaff mines and many are listed as producers of rich ore (Raymond, 1869-1875). The Joab Lawrence property was organized in 1879 and a steady outflow of ore was maintained for several years.

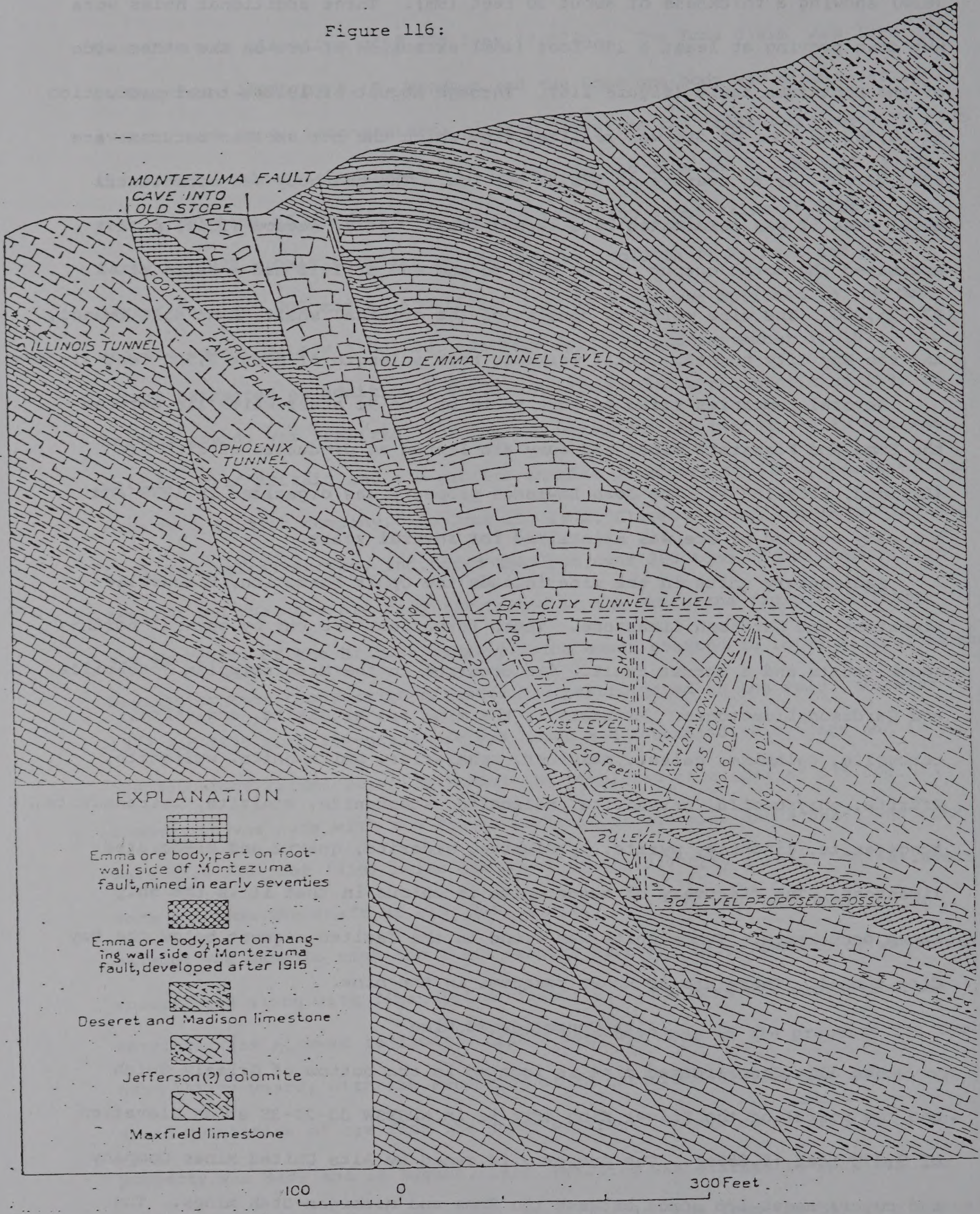
Sedimentary units in the mine include the Ophir Formation, Fitchville Limestone and Gardison Limestone. These formations are cut by several north-south faults and a thrust fault. Ore occurred in the Mississippian Fitchville and Gardison Limestones. Minerals in the mine are argentite, anglesite, cerussite, calamine, galena, massicot, sphalerite, smithsonite, wulfenite, azurite, chrysocolla, cervantite, malachite, stephenite, stolzite, tetrahedrite, tungstenite, limonite, pyrite, pyrolusite, siderite, quartz and brecciated limestone. The discovery of tungstenite is unique in that it is the only known occurrence. Tungstenite was found in the faulted segment below the Bay City tunnel. There are no known reserves in the mine.

Alta Consolidated Mine

The Alta Consolidated mine is located in the bottom of Grizzly Gulch and the portal of the Silver King adit is in NWSESW 33-2S-3E at an elevation of 9,370 feet (2,856m). The property is owned by Alta United Mines Company and covers about 128 acres between the Emma and Michigan-Utah mines. The mineralization was found in the 1870s and first production was 969 tons in

SECTION THROUGH THE EMMA ORE BODY

Figure 116:



Adapted from Calkins and Butler, 1943, p. 124

1877; 232 tons were shipped in 1878. From 1911-1919, 4,500 tons were shipped averaging $0.12 gold, 30.21 ounces silver, 10.9 percent lead and 2.22 percent copper (Calkins and Butler, 1943, p. 130). Mine workings consist of the Silver King adit and the lower Copper Prince adit, sometimes known as the Brooklyn. The Copper Prince adit is 95 feet (29m) lower in elevation. The earliest mine production came from old workings above the Silver King adit, but most came out through the Silver King adit. All of the adit portals were caved when the property was visited in the summer of 1976.

The ore bodies are along N. 40-60° E. trending fissures of which the Brooklyn or Brain fissure is the most prominent. Ore bodies are of two types: (1) contact and (2) replacements adjacent to intrusive dikes. The contact deposits consist of magnetite, contact silicates, pyrite and chalcopyrite. The replacement deposits are in favorable limestone beds in the Ophir, Fitchville, and Deseret Formations. Minerals in the ore bodies are galena, cerussite, plumbojarosite, wulfenite, chalcopyrite, argentite, magnetite, limonite, hematite, wollastonite, tremolite, diopside, and pyrite. The sedimentary units have been cut by dikes and metamorphosed by the Alta stock, which lies to the south. The Cambrian section is repeated along the top of the ridge along the Grizzly thrust bringing Carboniferous rocks on the west in contact with Cambrian units on the east. There are no known mineable reserves but some of the magnetite-copper mineralization that is present in the mine may prove to be economic in the future.

Michigan-Utah Mine

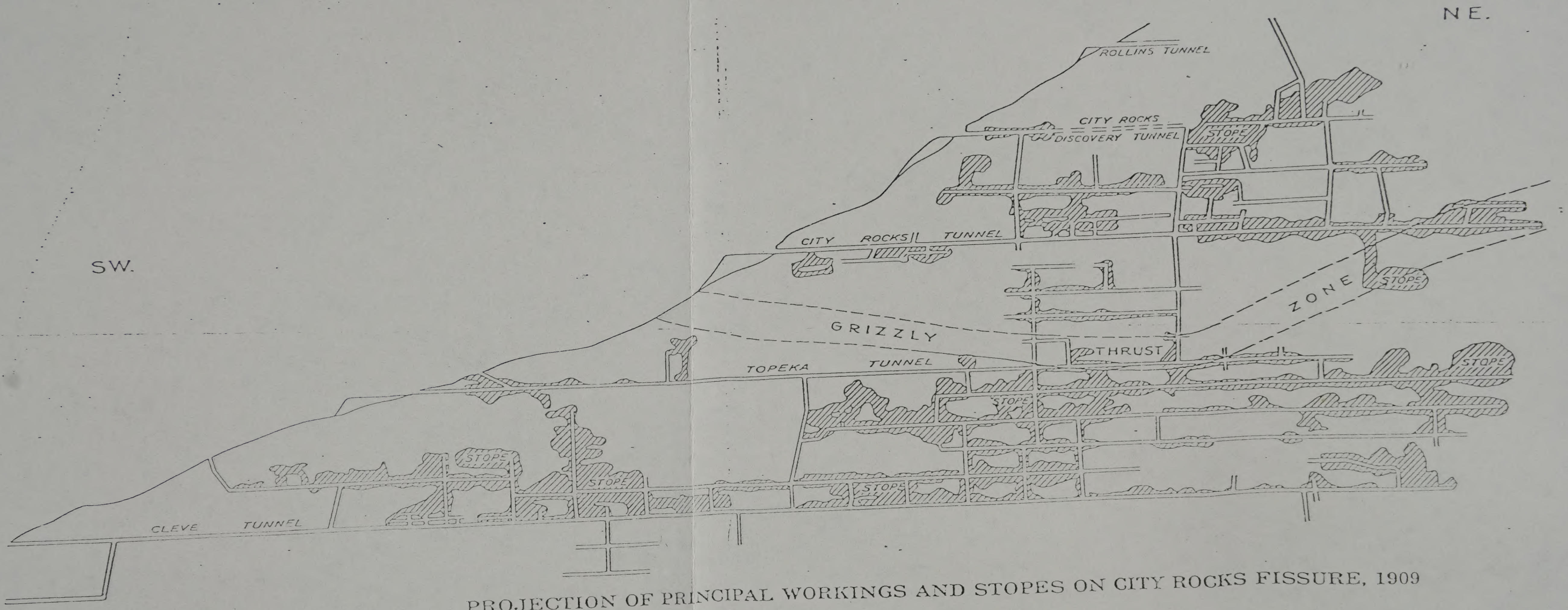
The Michigan-Utah property consists of at least 48 patented claims that lie at the head of Grizzly Gulch and extend into Honeycomb and Solitude Forks of Big Cottonwood Creek. The property lies in the middle of section 33 and extends into section 34 of T. 2 S., R. 3 E. All of the property is above 9,400 feet (2,865m) above sea level. The Michigan-Utah mine is a consolidation of mines including the Black Bess, City Rocks, Utah Mines Coalition, Lavinia, Grizzly, Darlington, Regulator, and Continental Alta. The early histories of the separate mines are incomplete. From 1901 to 1919 the Black Bess, City Rocks (figure 117), Continental-Alta, and Michigan-Utah had a recorded production of 50,681 tons of ore averaging $0.52 gold, 16.5 ounces silver, 9.12 percent lead and 1.2 percent copper (Calkins and Butler, 1943, p. 131). The mine consists of several adits and associated workings with a combined length totaling 65,000 feet (19,812m). The lowest adit, the Solitude tunnel, is in the Big Cottonwood drainage at an elevation of 8,102 feet (2,774m) above sea level. The lowest workings in the Little Cottonwood drainage is the Grizzly tunnel at 9,470 feet (2,886m). Most of the portals are caved (1976).

Sedimentary rocks on the property range in age from the Cambrian Tintic Quartzite through the Mississippian Deseret Limestone. These rocks have been brecciated by the Grizzly thrust and metamorphosed by the Alta stock. They are cut repeatedly by northeast-trending dikes. Ore occurs in contact deposits and in replacement fissures. Alteration has occurred along the contact with the stock and the mineral products are magnetite, calc-silicates, and sulfides; the latter are altered to oxides and carbonates. The contact area contains a low percentage of copper and a little gold, the material is too low grade to be economic. Production has mainly come from replacement fissure ore. The deposits are located along northeast-trending fissures dipping steeply to the north. The ore originally consisted of lead-zinc-silver sulfides that were later oxidized to oxide, carbonate, and molybdate minerals. Minerals found in the ore are galena, cerussite, anglesite, smithsonite, hemimorphite, jamesonite, argentite, plumbojarosite, wulfenite, chalcopyrite, ludwigite, malachite, azurite, wad, rhodochrosite, calcite, wollastonite, tremolite, and diopside. There are no known reserves on the property but the low-grade contact copper mineralization might be considered economic at a future date.

Columbus-Consolidated Mine

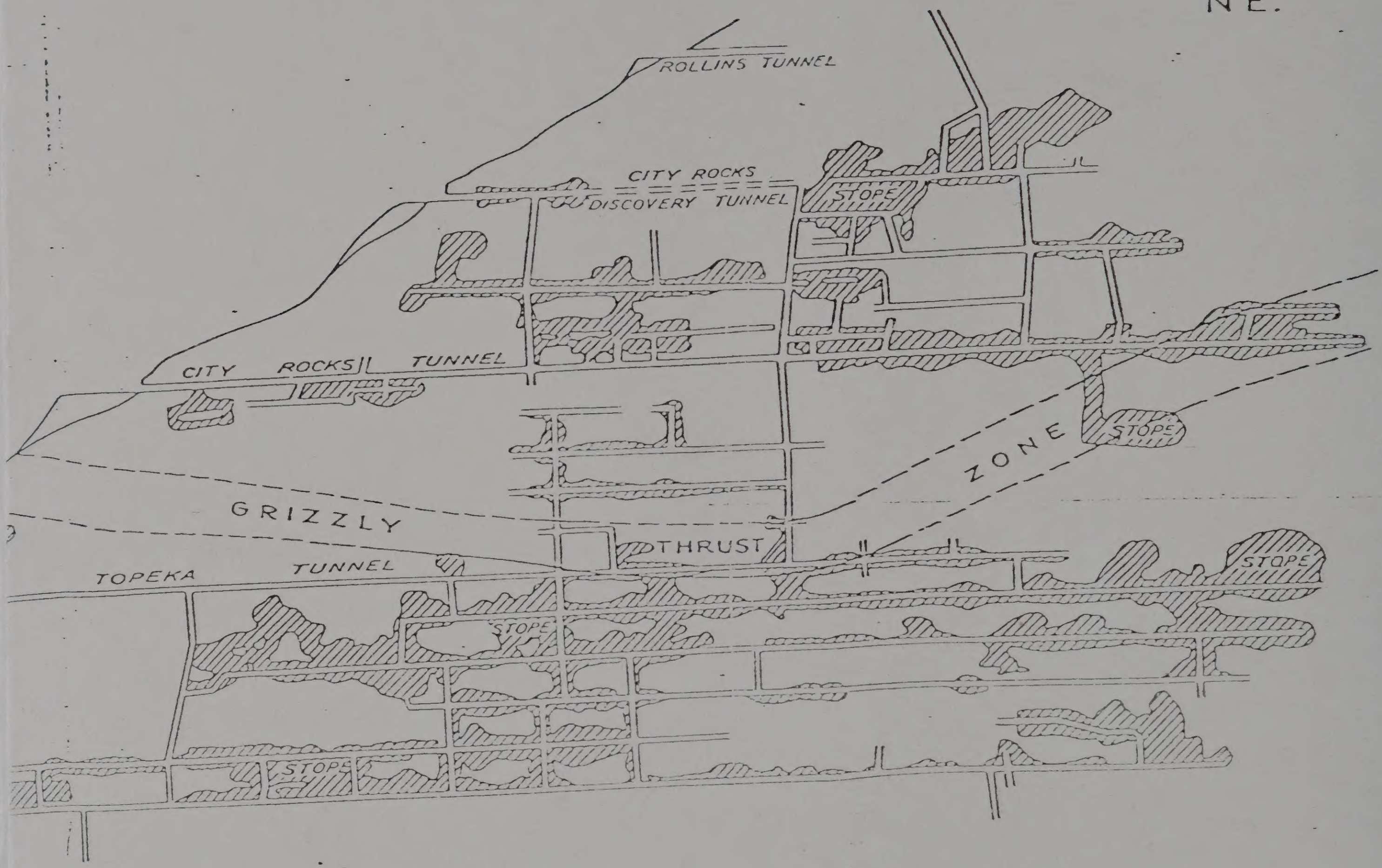
The Columbus Consolidated or Columbus mine is opened by the Columbus tunnel

Figure 117:



PROJECTION OF PRINCIPAL WORKINGS AND STOPES ON CITY ROCKS FISSURE, 1909

Adapted from Calkins and Butler, 1943, plate 46



NCIPAL WORKINGS AND STOPES ON CITY ROCKS FISSURE, 1909

1000 Feet

which is located just below the level of Utah Highway 210 in SWNESW 5-3S-3E at an elevation of 8,590 feet (2,615m). The mine first produced ore in the 1890s from the Yankee Blade workings and the Howland (Columbus-Rexall) tunnel. In 1902 a gravity mill was built to treat the lower grade ore; the first concentrates were shipped in 1904 and milling continued until 1914 when the structure was destroyed by fire. Later work was conducted from the Wasatch Drain tunnel. From 1902 through 1913, 54,000 tons of milling ore were mined yielding 13,644 tons of concentrates averaging $0.85 gold, 23.83 ounces silver, 4.46 percent copper, 11.94 percent lead. Direct smelting ore shipped during this time amounted to 32,792 tons averaging $1.40 gold, 32.88 ounces silver, 6.64 percent copper and 4.49 percent lead (Calkins and Butler, 1943, p. 119). Most of this ore was mined from the Brain fissure and the remainder from the Garfield fissure.

Mine workings consist of the Howland, Columbus, and Wasatch Drain tunnels. The Wasatch Drain tunnel was driven underneath the old workings to dewater them and connects to the 400 level of the Columbus mine. Rocks in the mine range in age from Precambrian Mineral Fork Tillite to the Mississippian Deseret Limestone. The structure is complex and prominent features include the Alta thrust zone, Snow fault, Howland fault, and the Brain and Garfield fissures. Minerals in the ore were galena, cerussite, anglesite, sphalerite, smithsonite, tetrahedrite, enargite, bornite, malachite, azurite, pyrite, limonite, hematite, and quartz. There are no known reserves in the mine.

South Hecla Mine

The portal of the Dwyer tunnel, that gives access to the South Hecla workings is immediately south of the Alta Ski Lodge on the south side of Little Cottonwood Canyon. The portal is in SWSENE 5-3S-3E at an elevation of 8,548 feet (2,605m). The South Hecla mine workings consist of several smaller mines owned by the Alta United Mines Co.; South Columbus, Alta-Hecla, Alta-Quincy, Columbus Wedge, Sells, Ivanhoe, and others. The discovery of small areas of mineralized rock led to the finding of the deeper, more valuable ore bodies.

Production between 1909 and 1911, from the above properties, amounted to 44,302 dry tons, averaging $0.56 gold, 17.46 ounces silver, 1.35 percent copper, and 6.34 percent lead. The principal mine workings consist of two main adits, the Dwyer and Quincy, which are 3,500 and 6,000 feet (1,067 and 1,829m) long respectively. The Quincy portal is at 9,658 feet (2,639m) above sea level. Mine development consists of 10,400 feet (3,170m) of tunnels, 17,215 feet (5,247m) of drifts and crosscuts, 3,200 feet (955m) of raises and 1,084 feet (330m) of shafts.

Sedimentary rocks found in the mine range in age from Precambrian to Mississippian and are complexly faulted, highly altered by contact metamorphism, and are cut by numerous igneous dikes. Contact deposits are found along the edge of the Alta stock. More important replacement ore bodies are along northeast-trending fissures and replacement has taken place laterally along favorable horizons in the sediments. Minerals found in the mine include aikenite, bismite, native bismuth, bismuthinite, bornite, chalcopyrite, enargite, galena, ludwigite, plumbojarosite, scheelite, smithsonite, sphalerite, tetrahedrite, wollastonite, garnet, and magnetite. Calkins and Butler (1943, p. 125) report that considerable low-grade oxide ore was left in the mine and only lead-silver ore of smelting grade was shipped. Perhaps an estimated 10,000 to 50,000 tons of ore averaging 5 ounces silver, 3 percent lead, 2 percent zinc, 0.2 percent copper and a trace of gold remain in the mine. The chance of finding more high grade ore on the property is good.

Columbus-Rexall Mine

The Columbus-Rexall mine was formed by consolidating workings of the Columbus Extension and the Rexall Silver and Copper Mining Companies. The property consists of 15 patented claims straddling the divide between Big and Little Cottonwood Canyons, the workings are opened by the Columbus-Rexall (Howland) adit which cuts the ore body 5,000 feet (1,524m) from the portal, 1,350 feet (391m) below the surface. The Howland portal is adjacent to Utah

Highway 210 in NESWNW 5-3S-3E at an elevation of 8,550 feet (2,606m). The previous companies expended much work with negative results prior to consolidation. Later, in 1917, an ore body was discovered and through 1919 mined ore averaged $5.73 gold, 9.21 ounces silver, 7.18 percent copper with a minor amount of lead. 8,799 tons were produced. After 1919, the mine was worked intermittently by lessees, but the amount of ore produced by them is unknown. Mine workings consist of a 5,400-foot (1,646m) adit and associated workings totaling 14,000 feet (4,267m). Underground workings connect with the Cardiff mine and the Wasatch Drain tunnel.

Sedimentary rocks in the mine consist of Cambrian Tintic Quartzite thrust over the Mississippian Deseret Limestone. The main ore body is below the thrust and occurs as a replacement in the Mississippian Gardison Limestone. Ore was also found in the limestone member of the Ophir Shale. Minerals found in the ore are tetrahedrite, enargite, bornite, galena, chalcopyrite, malachite, azurite, cerussite, anglesite, sphalerite, smithsonite, siderite, pyrite, quartz, limonite, and hematite. A small amount of ore may remain in the mine.

Albion Mine

The Albion mine is located near the top of Albion Basin and can be reached by a jeep trail from the Albion campground in the bottom of the basin. The shaft collar is in NESENE 8-3S-3E at an elevation of 10,075 feet (3,071m). The Albion mine is part of a group of patented claims covering 580 acres owned by the Albion Mining Company. The property is a consolidation of the Albion-Mining Co., Alta-Germania Mines and the Mineral and Flat Mining Co. The Albion claim was located on July 19, 1870 and in 1872 workings on the property consisted of an inclined shaft 200 feet (61m) deept with 800 feet (244m) of drifting. A million dollars worth of ore may have been produced from these workings, but is not recorded. Reported shipments show 300 tons of ore were produced prior to 1874 assaying 52 to 56.5 ounces silver and 28 to 34 percent lead. In 1874 about 70 tons were produced averaging 65 ounces silver and 50 percent lead. In 1886

200 tons were shipped and an unspecified amount was produced in 1887. Between 1905 and 1918 nearly 700 tons of lead-silver carbonate ore was shipped averaging \$2.76 gold, 41.53 ounces silver, 23.84 percent lead, and about 0.3 percent copper (Calkins and Butler, 1943, p. 129). Later work on the property was through the Albion and Alta-Quincy tunnels. At present the water supply for the town of Alta is derived from the Alta-Quincy tunnel.

Ore bodies are in the limestone member of the Ophir Shale and occur as replacements adjacent to northeast-trending fissures. The area is complexly faulted and the Ophir section is repeated several times. Ore bodies occurred as small pockets high enough in grade to mine. Minerals found in the ore are argentite, bournonite, galena, cerussite, chalcopyrite, sphalerite, smithsonite, barite, and pyrite. There are no known mineable reserves in the mine, but the possibility of low-grade ore remaining is likely.

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SANPETE COUNTY

Sanpete County, in the middle of the state, has been a very minor producer of lead and zinc and presently there are no active mines. These metals were produced together with a little silver and copper. Through 1976 it is estimated that less than 16,000 pounds of lead and 29,000 pounds of zinc were produced. The value at the time of production amounts to $1,927 for lead and $4,175 for zinc. At today's prices (January, 1977) the same amount of lead would be worth $4,247 and the zinc $10,656. One mining district, the Santobar, is found in the county and it has one mine. Sanpete County has little potential for the production of significant amounts of lead and zinc in the future. The county and its district are located on figure 118 and the annual county production is listed on table 31.

Santobar District

The Santobar district is located 5 miles (8km) northwest of Ephraim in the foothills of the San Pitch Mountains on the west side of Sanpete Valley (figure 119). No information is available concerning the early events of the district. The principal working is the Santobar mine, which is credited with 21 short tons of lead-zinc-silver ore in 1967, having a value of $200 to the ton (Pratt and Callaghan, 1970, p. 55). The value is presumed to be in error.

The rocks of the district include the Upper Cretaceous-Lower Tertiary North Horn Formation, Tertiary Flagstaff Limestone and the Tertiary Colton Formation (figure 120). The district is on the eastern limb of the Gunnison Plateau syncline. A number of east-west trending faults are found in the district. Mineralization is related to the faulting. Ascending ore-bearing solutions deposited the lead-zinc-silver minerals in the fault gouge and were enriched by oxidation. There has been limited exploration in the district and there are no known reserves. Future exploration may uncover small amounts of additional ore in the area.

Santobar Mine

The Santobar mine is located about 5 miles (8km) northwest of Ephraim in

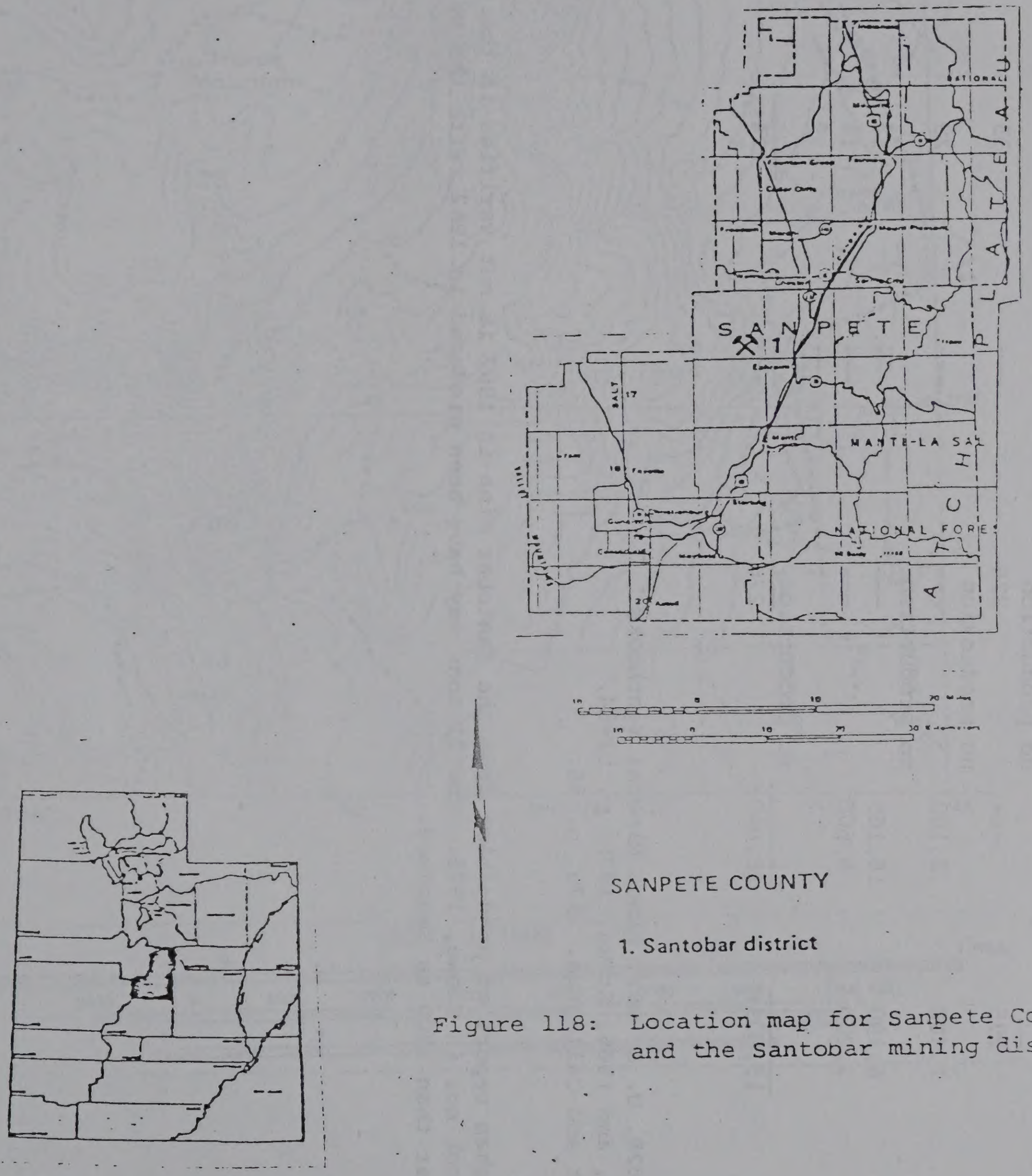


Figure 118: Location map for Sanpete County and the Santobar mining district

Table 31: Production of metals from Sanpete County, 1917-1976

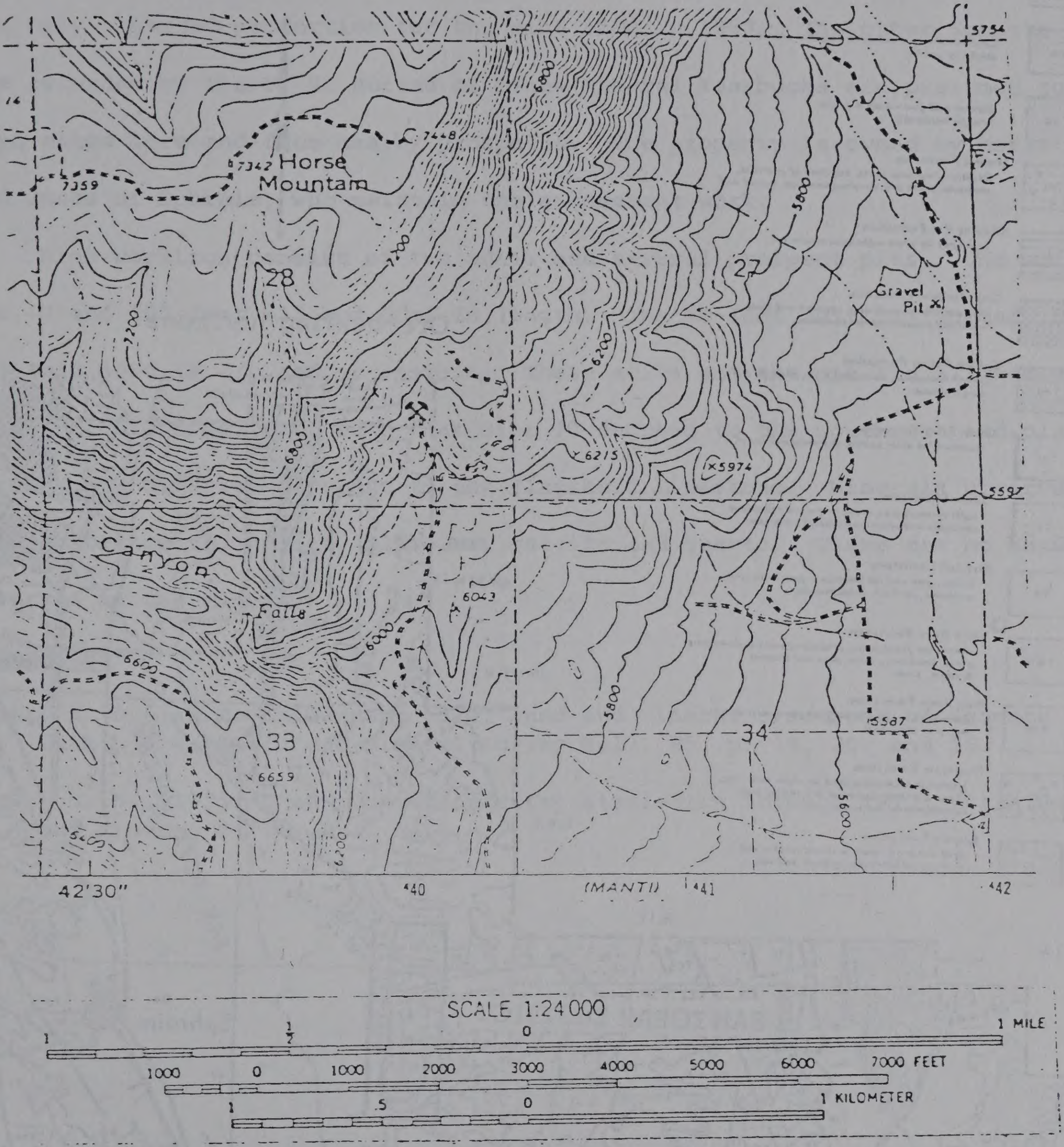
Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver Ozs.	Value
1917	16	5,814	---	---	---	---	$500
1918-1927				no production			
1928	13	295	---	226	---	35	71
1929-1961				no production			
1962	21	1,400	2,100	---	---	29	402
1963-1964				no production			
1965	402	6,100	18,100	---	---	44	3,651
1966	135	2,200	8,600	---	---	16	1,641
1967*	21?	?	?	?	---	?	4,200?
1968-1976				no production			
Totals	608? (587)	15,809+	28,800+	226	---	124+	$10,465? ($ 6,265)

Sources: 1917 and 1928, U. S. Bur. Mines Mineral Yearbooks
1962, 1965, and 1966, Stowe, 1975, p. 51-54.
1967, Pratt and Callaghan, 1970, p. 55.

*The Pratt and Callaghan report of production from the Santobar mine in 1967 is not verified in the U. S. Bur. Mines Mineral Yearbook nor in Stowe, 1975. The 21 tons may have been produced in 1962, with the value set at $20 per ton rather than $200 as reported.

Figure 119

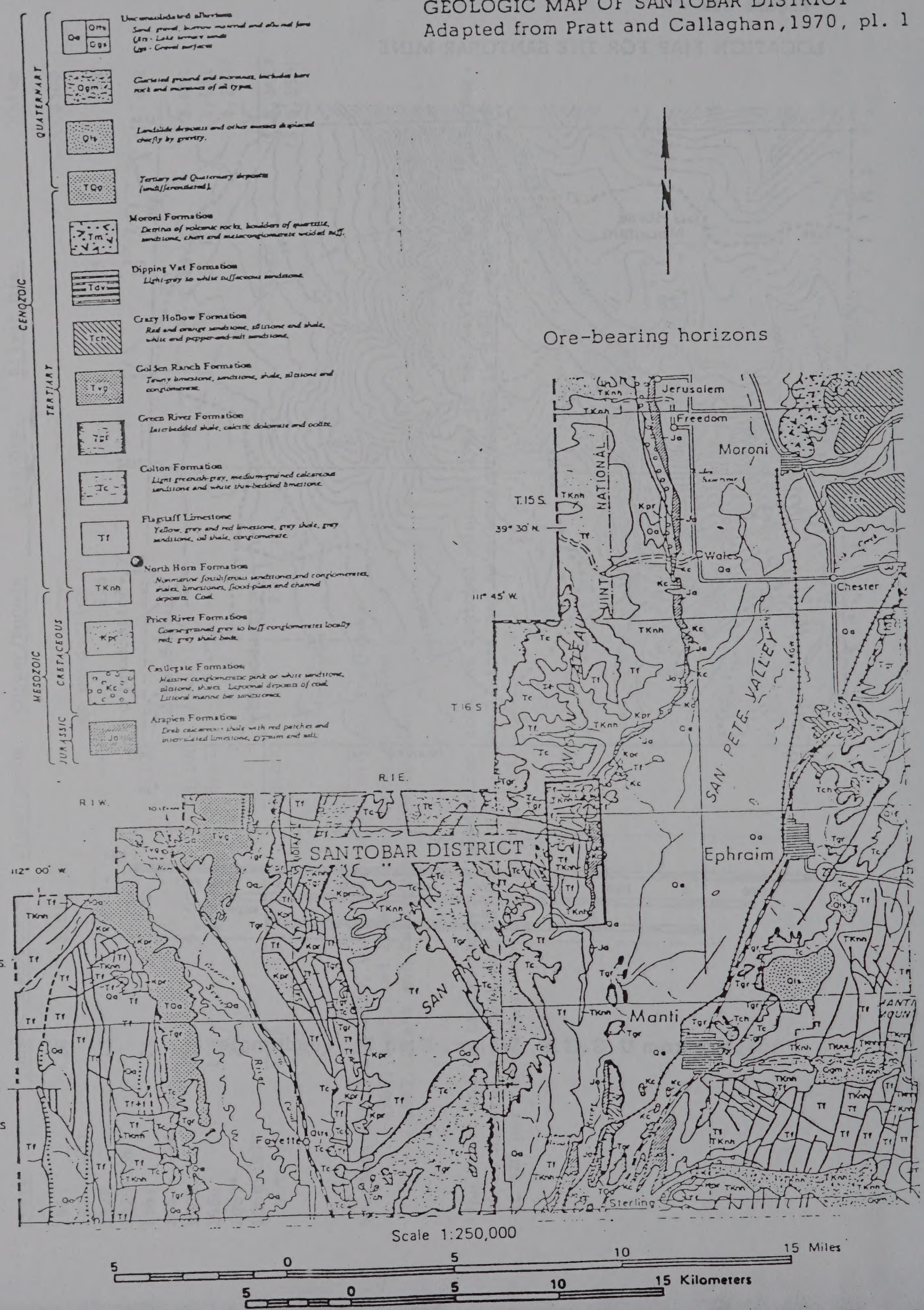
LOCATION MAP FOR THE SANTOBAR MINE



Adapted from U.S.G.S. Wales, Utah 7½' quadrangle

Figure 120:

GEOLOGIC MAP OF SANTOBAR DISTRICT
Adapted from Pratt and Callaghan, 1970, pl. 1


EXPLANATION
CENOZOIC
QUATERNARY
Qa Qm Qgs
Unconsolidated alluvium
Sand, gravel, barrow material and alluvial fans
Qm - Lake terrace sands
Qgs - Gravel surfaces
Qgm
Garlated ground and moraines, includes bare rock and moraines of all types.
Qls
Landslide deposits and other masses displaced chiefly by gravity.
TQo
Tertiary and Quaternary deposits (undifferentiated).
TERTIARY
Tm
Moroni Formation
Detritus of volcanic rocks, boulders of quartzite, sandstone, chert and metaconglomerate welded tuff.
Tdv
Dipping Vat Formation
Light-grey to white tuffaceous sandstone.
Tch
Crazy Hollow Formation
Red and orange sandstone, siltstone and shale, white and pepper-and-salt sandstone.
Tvg
Golden Ranch Formation
Tawny limestone, sandstone, shale, siltstone and conglomerate.
Tgr
Green River Formation
Interbedded shale, calcitic dolomite and oolite.
Tc
Colton Formation
Light greenish-grey, medium-grained calcareous sandstone and white thin-bedded limestone.
Tf
Flagstaff Limestone
Yellow, grey and red limestone, grey shale, grey sandstone, oil shale, conglomerate.
TKnh
North Horn Formation
Nonmarine fossiliferous sandstones and conglomerates, shales, limestones, flood-plain and channel deposits. Coal.
MESOZOIC
CRETACEOUS
Kpr
Price River Formation
Coarse-grained grey to buff conglomerates locally red; grey shale beds.
Kc
Castlegate Formation
Massive conglomeratic pink or white sandstone, siltstone, shales. Lagoonal deposits of coal. Littoral marine bar sandstones.
JURASSIC
Ja
Arapien Formation
Drab calcareous shale with red patches and interbedded limestone, gypsum and salt.
N
Ore-bearing horizons
Jerusalem
Freedom
Moroni
Wales
Chester
NATIONAL
UINTA
PLATEAU
SAN PETE VALLEY
T.15 S.
39° 30' N.
111° 45' W.
T.16 S.
R.1 E.
R.1 W.
112° 00' W.
T.17 S.
39° 15' N.
T.18 S.
SANTOBAR DISTRICT
Ephraim
Manti
Fayette
Sterling
SAN PITCH
Qa
Ja
Kc
Kpr
TKnh
Tf
Tc
Tgr
Tch
Tvg
Qls
Qgm
Scale 1:250,000
5 0 5 10 15 Miles
5 0 5 10 15 Kilometers

NWSESE 28-16S-2E at an elevation of 6,330 feet (1,929m). The mine is 1/2 mile (0.8km) north of the mouth of Rock Canyon on the west side of Sanpete Valley. The only reported production for the mine came in 1967. The other Sanpete County ore recorded by the U. S. Bureau of Mines Mineral Yearbooks are presumed to have been mined here and from nearby prospects. The property is owned by Mssrs. Jensen and Jones of Ephraim, who maintain the assessment work.

Mine workings consist of two adits and several prospect pits. The adits are 40 and 100 feet (12 and 30m) in length. The 40-foot adit is flooded, but the 100-foot adit is dry and accessible. These adits and the ore are aligned along a N. 15° E. trending fault zone that dips 70 degrees to the southeast and places the North Horn Formation adjacent to the Flagstaff Limestone. Minerals observed were galena, cerussite, pyrite, limonite, calcite and quartz. There are no known reserves in the mine.

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SEVIER COUNTY

There are two mining districts in Sevier County which have produced lead and zinc ore and both are of minor importance. Neither shows promise for the discovery of large ore bodies. In 1976 there were no active mines. The lead and zinc mines produced minor amounts of copper and silver as well, perhaps 200 pounds of the former and 50 to 60 ounces of the latter. Zinc production was more important and through 1976 more than 108,000 pounds of zinc and less than 17,000 pounds of lead were mined valued at $8,598. Other mines in the county have produced precious metals, but have not yielded lead and zinc. Table 32 lists the annual production of lead and zinc for the county. Both mining districts, Redmond and Salina Creek, are located in the northern part of the county, which is found just south of the state's center (figure 121).

Redmond District

The Redmond district is in northern Sevier County, in the western foothills of the Cedar Mountains (figure 122). The mining district is located 3 miles (4.8km) east of Redmond and 5 miles (8km) northeast of Salina. The Redmond Silver (Salina Zinc) mine is the most significant mine in the district. Early history is sketchy and the earliest reported production was achieved in the World War I era (Heyl, 1963, p. B85). Sporadic production followed and ended in 1950. Since 1928, the district has been credited with the production of 206 short tons of oxidized zinc and zinc-lead ore.

The district lies on a northeast-trending anticline and faults bring the Tertiary Green River Formation against the Jurassic Arapien Shale (figures 123 and 124). Oxide zinc-lead mineralization occurs as a replacement in the brecciated Green River limestones and in the Arapien Shale along a northeast-trending fault. The ore occurs as lenses and pockets along the fault. Mining has removed the higher grade ore leaving only small amounts of low-grade material.

Table 32: Production of lead and zinc from Sevier County, 1906-1976

Year	Lead/Pounds	Zinc/Pounds	Value
1906	18	---	$1
1907-1911		no production	
1912	7,093	---	319
1913-1915		no production	
1916	96		7
1917-1928		no production	
1929	683	25,652	1,736
1930	7,520	50,402	2,778
1931-1940		no production	
1941	400	10,000	773
1942-1943		no production	
1944	100	3,000	350
1945-1946		no production	
1947	---	4,400	532
1948-1949		no production	
1950	200	4,300	638
1951-1955		no production	
1956	100	2,700	386
1957-1967		no production	
1968	600	8,000	1,078
1969		production negligible	
1970-1976		no production	
Totals	16,810	108,454	$8,598

Source: U. S. Bur. Mines Mineral Yearbooks except 1968 estimate.

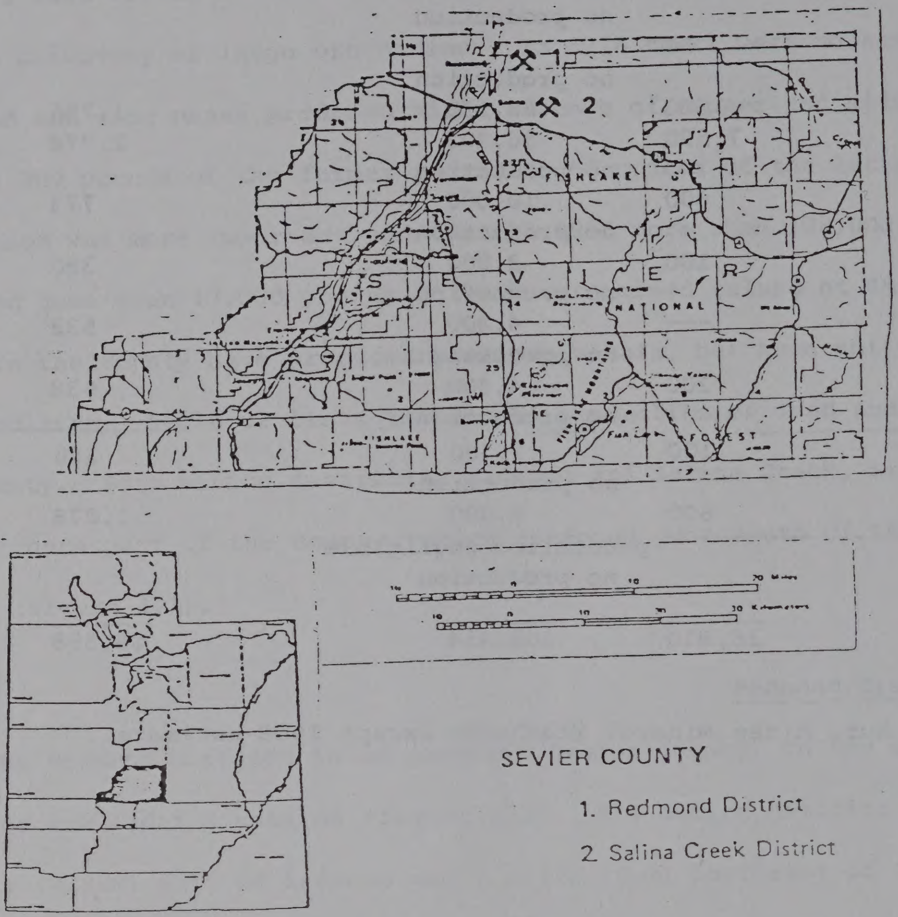


Figure 121: Location map of Sevier County and its lead-zinc mining districts.

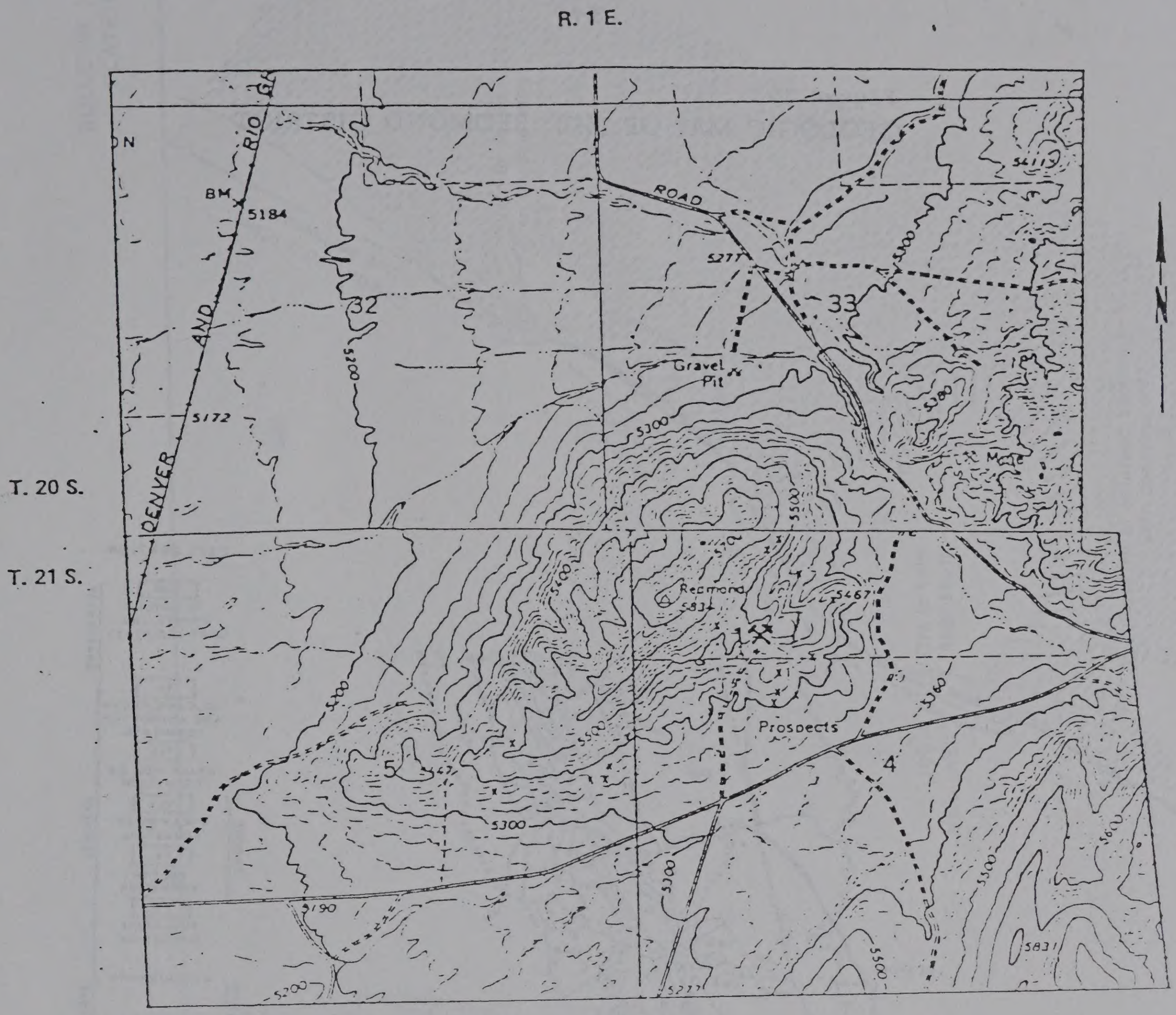
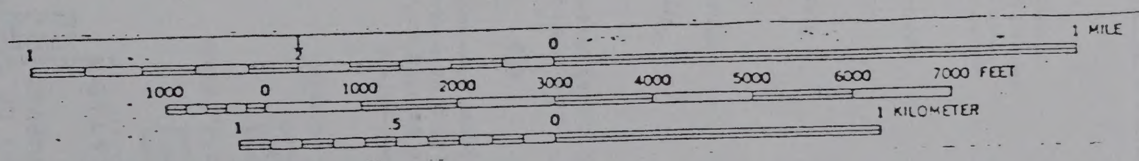


Figure 122: Topographic map of the Redmond district

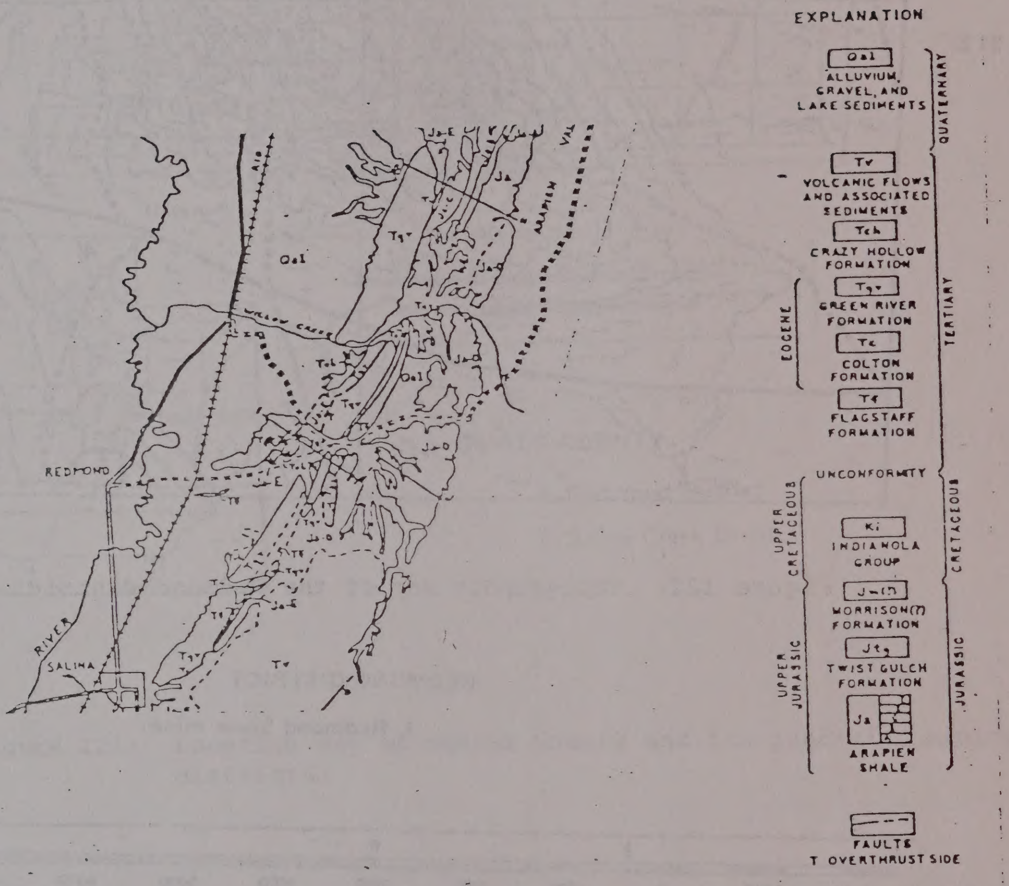
REDMOND DISTRICT

1. Redmond Silver mine



Adapted From: USGS Redmond 7½′ Quadrangle

Figure 123:
GEOLOGIC MAP OF THE REDMOND DISTRICT

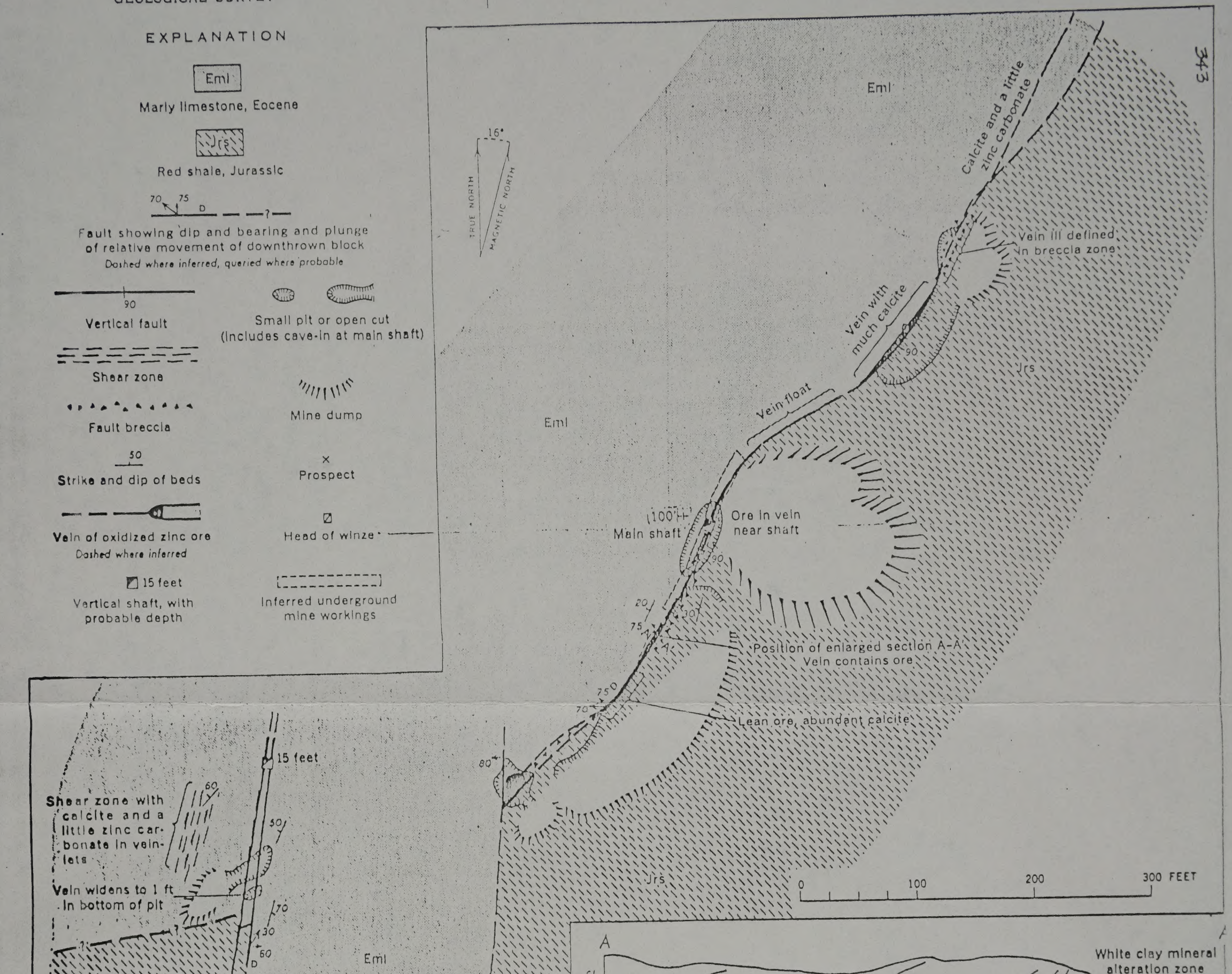


Adapted from Hardy, 1952, p. 50-51

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BULLETIN 1135-B
PLATE 9

343

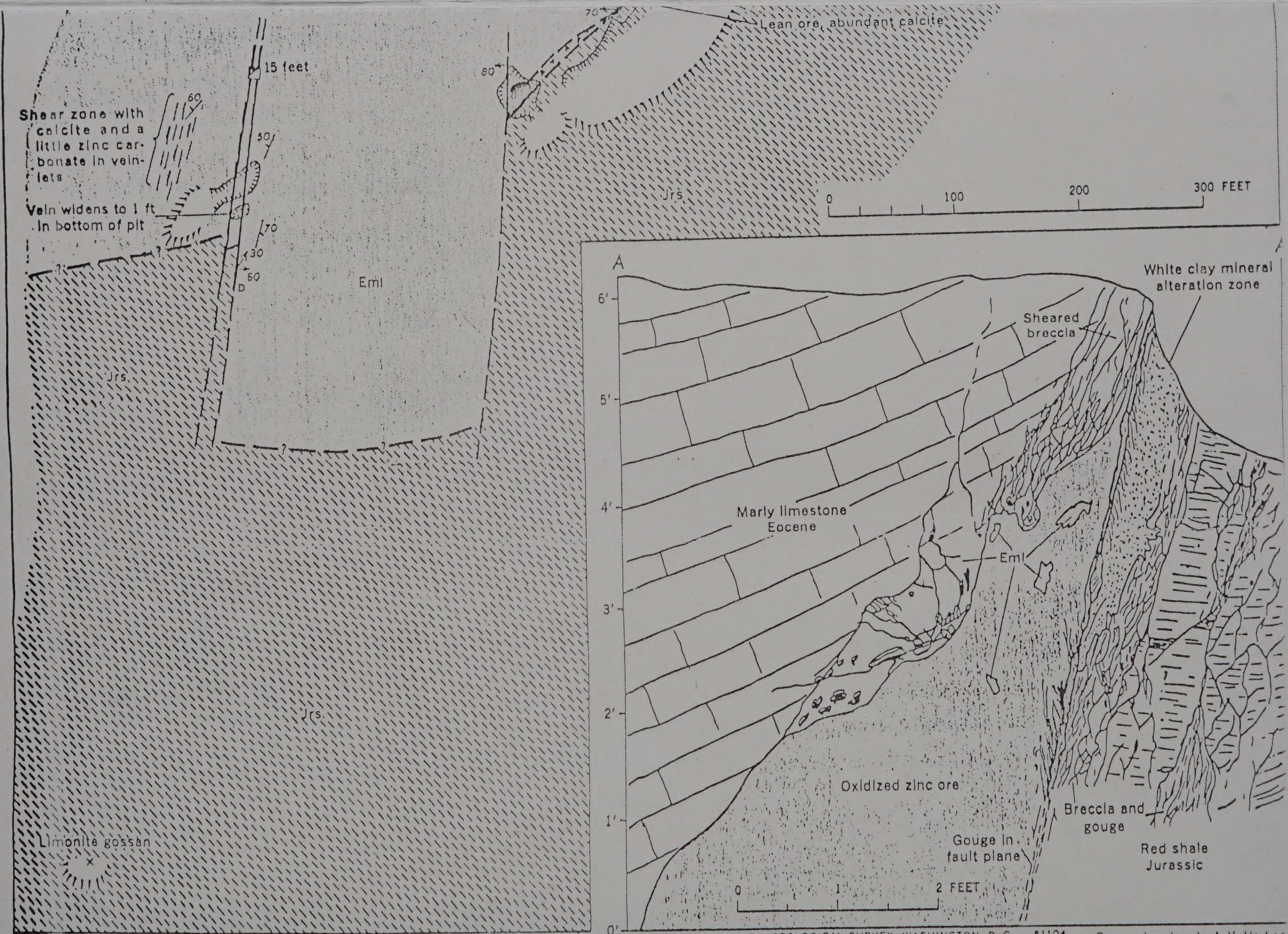

EXPLANATION
Eml
Marly limestone, Eocene
Jrs
Red shale, Jurassic
70
75
D
?
Fault showing dip and bearing and plunge of relative movement of downthrown block
Dashed where inferred, queried where probable
90
Vertical fault
Small pit or open cut (includes cave-in at main shaft)
Shear zone
Mine dump
Fault breccia
50
Strike and dip of beds
×
Prospect
Vein of oxidized zinc ore
Dashed where inferred
Head of winze
15 feet
Vertical shaft, with probable depth
Inferred underground mine workings
16°
TRUE NORTH
MAGNETIC NORTH
Eml
Calcite and a little zinc carbonate
Vein ill defined in breccia zone
Vein with much calcite
90
Jrs
Vein float
Eml
100±
Main shaft
Ore in vein near shaft
90
20
50
75
Position of enlarged section A-A
Vein contains ore
75
70
Lean ore, abundant calcite
80
15 feet
60
Shear zone with calcite and a little zinc carbonate in veinlets
50
Vein widens to 1 ft in bottom of pit
70
30
60
D
Eml
Jrs
Jrs
Jrs
Limonite gossan
0
100
200
300 FEET
A
6′
5′
4′
3′
2′
1′
0′
White clay mineral alteration zone
Sheared breccia
Marly limestone Eocene
Eml
Oxidized zinc ore
Breccia and gouge
Gouge in fault plane
Red shale Jurassic
0
1
2 FEET

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—61104

Base and geology by A. V. Heyl an
Priestly Toulmin, 3rd, 1954

Figure 125;

GEOLOGIC MAP AND SECTION OF THE REDMOND SILVER MINE, REDMOND, UTAH, SHOWING THE OXIDIZED ZINC ORE VEINS



INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—61104

Base and geology by A. V. Heyl an
Priestly Toulmin, 3rd, 1954

Figure 125:

GEOLOGIC MAP AND SECTION OF THE REDMOND SILVER MINE, REDMOND, UTAH, SHOWING THE OXIDIZED ZINC ORE VEINS

Figure 124:

STRATIGRAPHIC COLUMN FOR THE REDMOND DISTRICT

Formations in central Utah (Spieker, Hardy and Spieker).

AGE		FORMATION	CHARACTER	THICKNES (Feet)
TERTIARY		Axtell	Conglomerate, gravel	Unknown
		Unconformity		
		Lava flows	Trachyte and related rocks	0-500+
		Unconformity		
		Pyroclastic rocks	Gray sandstone, buff limestone, shale, bentonite, volcanic ash	0-700+
		Unconformity		
	Eocene	Crazy Hollow	Gray sandstone, red shale	0-600+
	●	Green River	Green-gray shale, buff limestone	0-800+
		Colton	Red and green-gray shale	0-300+
	Paleocene(?)	Flagstaff	Gray limestone and shale, red siltstone, conglomerate	0-800+
		Local Unconformity		
	Paleo-cene	North Horn	Not present in mapped area.	
CRETACEOUS	Upper Cretaceous	Price River	Not present in mapped area.	
		Unconformity		
		Indianola group	Brown sandstone, conglomerate	7,000+
JURASSIC	Upper Jurassic	Morrison (?)	Conglomerate, gray sandstone variegated shale, limestone	300-1,00
		Twist Gulch	Red siltstone, reddish-gray sandstone	3,000
	●	Arapien shale	Gray shale and sandstone. Red shale and gypsum in upper part; thinbedded argillaceous limestone in lower part.	3,000+

● Ore-bearing horizons

Adapted from Hardy, 1952, p. 41

Redmond Silver (Salina Zinc) Mine

The Redmond Silver mine is located about 3 miles (4.8km) east-northeast of the town of Redmond and is in the foothills of the Cedar Mountains at an elevation of 5,505 feet (1,678m) above sea level. The shaft collar is in SWNENW 4-21S-1E. The mine is situated along a fault which strikes N. 40° E. and dips 75 degrees to the northwest. Heyl (1963, p. B86) describes the ore bodies as lenticular veins of hydrozincite, some smithsonite, calcite and a little cerussite and limonite. This ore occurs in the fault zone that places Jurassic Arapien Shale against the Tertiary Green River Formation. North-striking cross-faults displace the main fault and pockets of oxidized zinc minerals occur at the junctions (figure 125).

Workings of the mine consist of a vertical shaft, 100 to 200 feet (30-61m) deep, from which several levels have been driven. The mineralized zone along the fault has been prospected for 900 feet (274m) by dozer cuts. Initial production from the mine was around World War I and Heyl reports that 25 to 30 percent zinc was mined between 1929 and 1930. Since 1928 the mine has produced 206 short tons of oxide zinc and zinc-lead ore containing a little recoverable copper and silver. Some lower grade ore remains in the mine and exploration along the fault down dip as well as along strike may find additional ore.

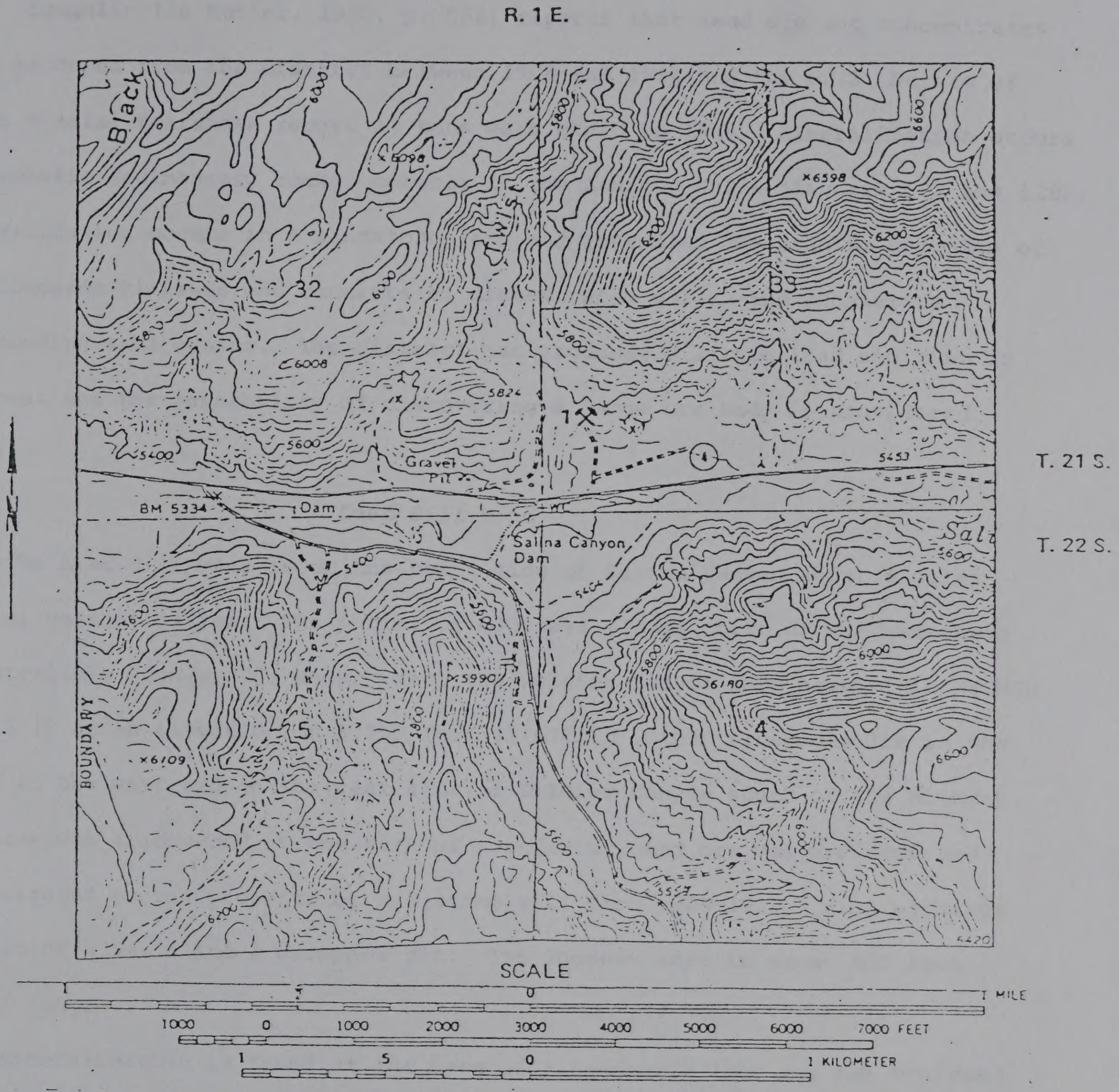
References:

Hardy, C. T., 1952, Eastern Sevier Valley, Sevier and Sanpete Counties, Utah: Utah Geol. and Mineral Survey Bull. 43, p. 35, 50, and 51.

Heyl, A. V., 1963, Oxidized zinc deposits of the United States, Pt. 2, Utah: U. S. Geol. Survey Bull. 1135-B, p. 85-86.

Salina Creek District

The Salina Creek mining district is in Salina Canyon about 4 miles (6.4km) east of the town of Salina (figure 126). Exploration in the district has been limited to two mines and the area surrounding them, only one has produced any



SALINA CREEK DISTRICT

1. Lead Hill mine

Figure 126: Topographic map of the Salina Creek mining district.

Adapted From: USGS Salina 7½' Quadrangle

ore. Loughlin (in Butler, 1920, p. 558) reports that lead ore and concentrates were produced from the district between 1908 and 1912 and the U. S. Bureau of Mines Mineral Yearbooks report 17 tons were mined in 1944. Mineralization occurs in Jurassic sedimentary rocks, notably in the Arapien Shale (figures 127 and 128). Mineralization occurs in a sandstone lens and resembles the uranium deposits of the Colorado Plateaus and consists of disseminated galena and sphalerite surrounding sand grains. The district has produced a little lead and zinc in the past and the possibility of discovering a large ore body is considered small.

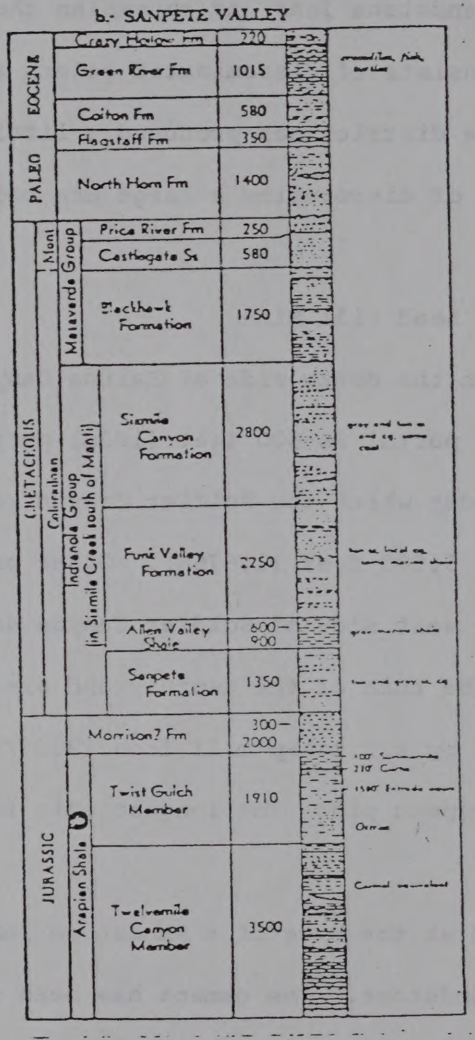
Lead Hill Mine

The Lead Hill mine is on the north side of Salina Canyon about 4 miles 6.4 km) east of Salina. The portal is 600 feet (183m) north of the underpass on Interstate Highway 70, under which the Soldier Canyon road passes, in NWSWSW 33-21S-1E at an elevation of 5,500 feet (1,676m). Other prospects lie in the gulch to the west and on the west side of Soldier Canyon south of the highway. The mine was discovered at the turn of the Century and ore was produced and concentrated on the property by a 5 stamp mill from 1908-1912. Mine workings consist of 4 adits and a prospect pit. The longest adit is about 800 feet (244m) long.

Mineralization is found at the base of a sandstone lens and has replaced the calcite cement in the sandstone. The cement has been replaced in lenses and streaks through a vertical thickness of up to 6 feet (1.8m) by galena, cerussite, sphalerite, pyrite, chalcocite, malachite, azurite, and celestite. Mine workings have followed the mineralized zone, which strikes N. 30° E. and dips 10 degrees to the northwest, down dip for at least 600 feet (183m). The mineralized bed ranges in thickness from 2 inches to 6 feet (5cm-1.8m) and samples cut across the mineralized sandstone average 2.5 percent lead, 0.5 percent zinc, and 0.1 ounces silver to the ton. A select high grade sample

Figure 128:

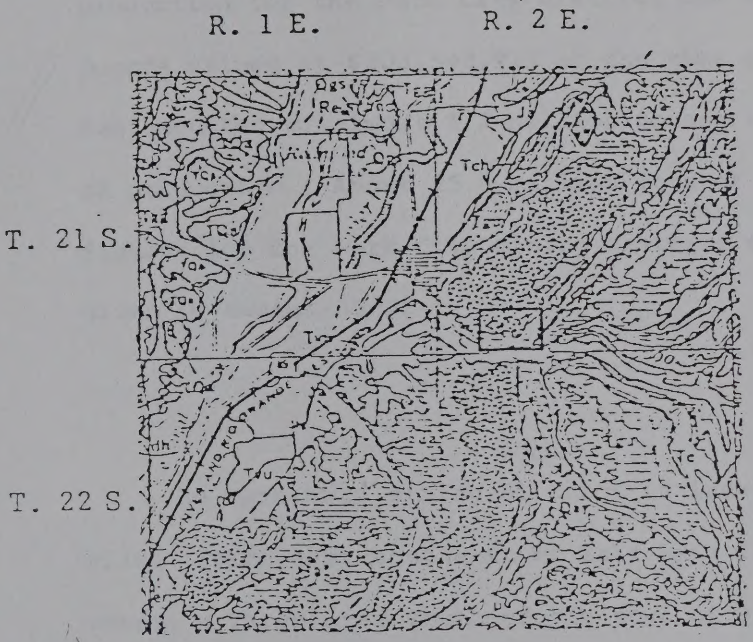
STRATIGRAPHIC COLUMN FOR THE SALINA CREEK DISTRICT



⊕ ore-bearing horizon

Adapted from L.F. Hintze, 1973, Geologic History of Utah, p.141

Figure 127: GEOLOGIC MAP OF THE SALINA CREEK MINING DISTRICT



Adapted from Geologic Map of Utah, Southwest quarter, by Hintze, 1963

TERTIARY

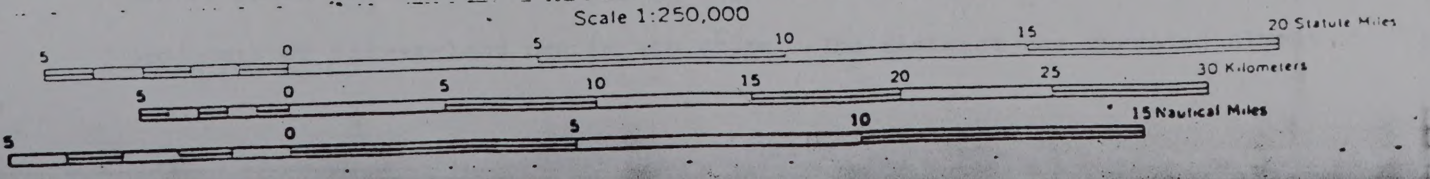
- Tgg — **Gray Gulch Formation** *Complex aggregation of pyroclastic rocks with colorec sandstone, limestone, and shale, Sevier Valley only Oligocene?*
- Tbk — **Bald Knoll Formation** *Light gray siltstone, local in Sevier Valley. Late Eocene?*
- Tch — **Crazy Hollow Formation** *Red to white sandstone and siltstone, local conglomerates. Late Eocene?*
- Tvg — **Goldens Ranch Formation** *Chiefly volcanic conglomerate with minor flows on limestone with Eocene fossil plants.*
- Tgu — **Green River Formation** *Fresh water limestone with minor sandstone and conglomerate. Middle Eocene.*
- Tc — **Colton Formation** *Fluvial red beds with channel sandstone lenses. Paleocene?*
- Tf — **Flagstaff Limestone** *Gray to blue-gray fossiliferous, fresh-water limeston Paleocene.*
- TKnh — **North Horn Formation** *Variegated continental beds; dinosaurs in lower pc Paleocene mammals above.*

MESOZOIC

Upper Cretaceous

- Ki — **Indianola Formation or Group** *Conglomerate, sandstone and siltstone, chiefly red.*
- Ksx — **Sixmile Formation or Member** *Sandstone, conglomerate and a few coal beds.*
- Kfv — **Funk Valley Formation or Member** *Light-colored sandstone and gray shale, locally conglomeratic.*
- Kav — **Allen Valley Formation or Member** *Gray marine shale.*
- Kspt — **Sanpete Formation or Member** *Light-colored sandstone and conglomerate, minor shale.*
- Kpr — **Price River Formation** *Sandstone and mudstone, fluvial and marine.*
- Kc — **Castlegate Sandstone** *Cliff-forming, light-colored deltaic sandstone.*
- Kbh — **Black Hawk Group** *Sandstone, shale, and coal. Chief COAL PRODUCER in Wasatch Plateau and Book Cliffs.*

- Jm — **Morrison Formation** *Variegated continental sediments, shale and stone.*
- Ja — **Arapien Formation or Group** *Variegated red to gray siltstone, sandstone an stone, ROCK SALT and GYPSUM.*



of ore from the bin near the portal assayed 11 percent lead, 4 percent zinc and 0.22 ounces silver to the ton. The mine contains in excess of 100 tons of low-grade mineralized rock. Future exploration in the area might discover additional mineralization in the area.

Reference:

Butler, B. S. and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672p.

SUMMIT AND WASATCH COUNTIES

Almost all of the lead-zinc production from Summit and Wasatch Counties has come from the Park City mining district, including Blue Ledge, Elkhorn, Marble, Snake Creek, and Uinta districts. The counties are located in the northeastern part of the state near the place where Wyoming cuts the corner out of Utah. The Park City district is located in the southeast corner of Summit County and the northwest corner of Wasatch County (figure 128). Lead and zinc have been produced together with silver, gold, and copper. The lead production for the Park City district has amounted to almost 2.9 billion pounds valued at $203,548,915 at the time of production. The zinc production has amounted to almost 1.2 billion pounds valued at $125,920,505 at the time of production. About 25.5 million tons of ore have been produced. Production figures for the Park City mining district and for the individual counties are given in tables 33-35.

Park City District

The Park City mining district is located in the Wasatch Range about 18 miles (29km) east-southeast of Salt Lake City (figure 129). The district covers a large area south of the town of Park City and borders Big and Little Cottonwood districts on the west along the Salt Lake County line. The district is the second largest producer of lead and zinc in the state of Utah. Production from the district has been almost continuous since its predecessor districts were organized in 1869. The Park City mining district is a composite of the Blue Ledge, Elkhorn, Marble, Snake Creek, Uinta, and restricted Park City districts. The first discovery was made on the Walker and Webster claim in 1869 and further prospecting added several others. The first shipment of ore was made in 1870. In 1872 the Ontario silver ledge was discovered by Rector Steen and started the district on its way to being one of the larger producers of silver-lead ore in the state. The district has operated almost

Figure 128:
LOCATION MAP OF SUMMIT AND WASATCH COUNTIES

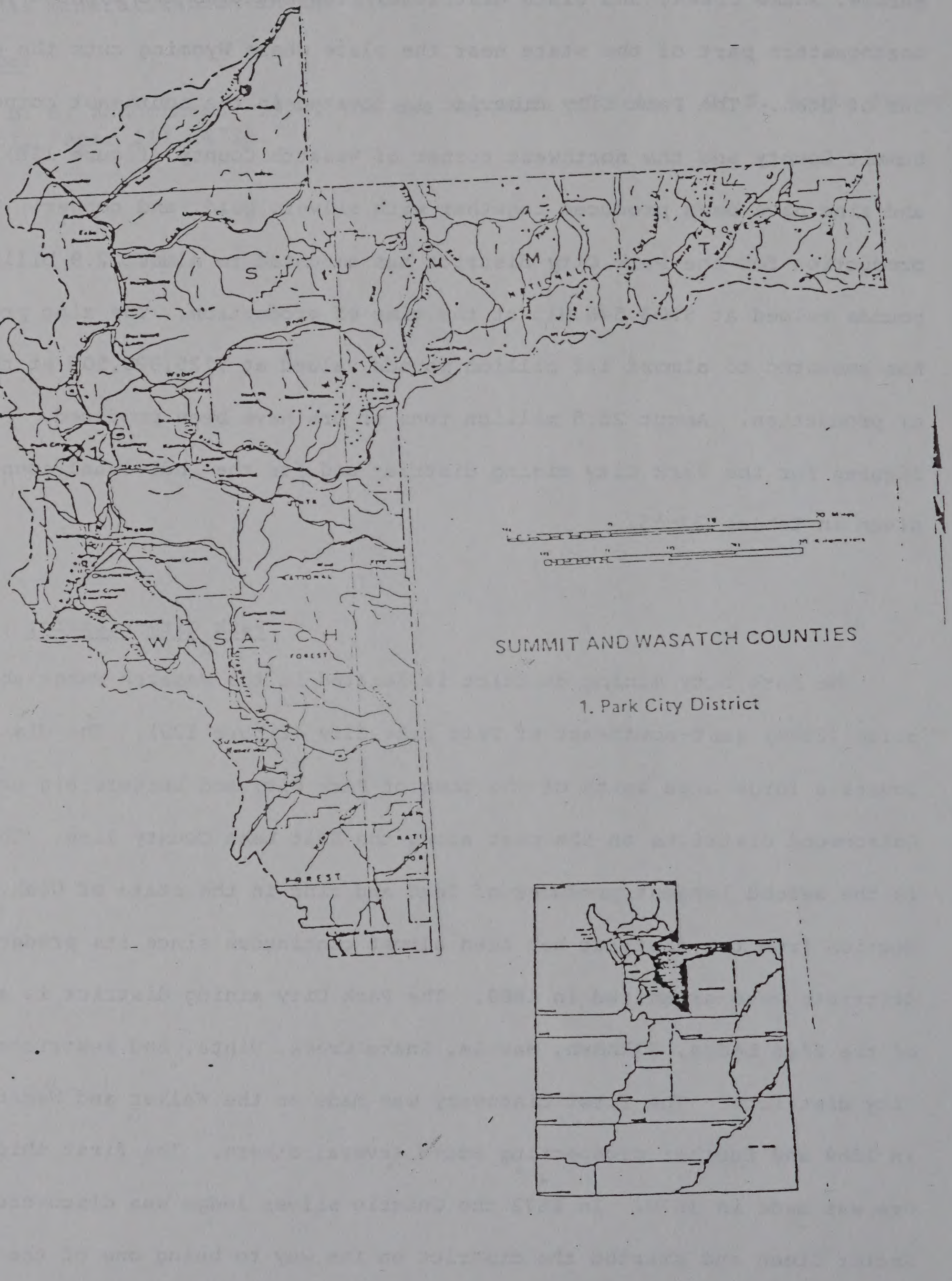


Table 33: Production of metals from the Park City mining region, 1870-1976 (Summit and Wasatch Cos. combined)

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1870-1880	?	11,954,000	---	---	---	6,217,716	$7,888,353
1881-1890	217,170*	145,412,800	---	---	17,860.00	27,531,180	35,008,512
1891-1900	184,983*	295,716,775	---	1,563,325	53,591.00	31,830,831	35,666,648
1901-1910	1,282,404*	519,180,571	23,330,131	17,776,611	107,244.19	46,383,365	55,997,465
1911-1920	2,249,263	351,544,180	51,013,989	14,521,899	43,978.54	30,527,363	47,288,722
1921-1930	5,153,385	634,763,053	257,962,267	20,200,314	166,707.15	56,905,123	101,578,692
1931-1940	1,886,998	291,012,465	205,393,436	7,767,364	64,258.37	23,995,357	43,396,459
1941-1950	3,366,517	238,220,600	206,881,100	10,887,000	187,925.00	16,448,911	65,195,310
1951-1960	2,216,056	150,921,304	197,251,500	9,796,400	244,367.00	9,555,593	63,359,885
1961	214,513	18,540,000	20,574,000	816,000	38,154.00	881,816	5,651,954
1962	245,784	12,548,000	15,900,000	135,400	3,601.00	761,766	4,102,942
1963	358,190	20,420,000	24,986,000	1,144,000	21,273.00	1,029,875	7,493,554
1964	281,130	19,960,000	21,214,000	1,582,000	34,273.00	908,452	8,389,881
1965	386,756	19,798,400	9,214,779	1,746,000	133,224.00	1,227,114	9,691,461
1966	336,595	23,714,000	22,562,000	2,164,000	63,619.00	1,168,648	11,375,790
1967	220,264	19,666,000	19,504,000	1,888,000	108,178.00	1,033,895	9,830,390
1968	244,000	18,924,000	18,026,000	2,130,000	130,028.00	1,267,600	10,103,000
1969	219,200	22,338,000	20,810,000	2,318,000	53,624.00	1,087,763	11,641,000
1970	187,516	17,002,000	15,230,000	2,274,000	51,537.00	880,203	9,734,193
1961-1970	2,693,948	192,910,400	188,020,779	16,197,400	637,511.00	10,247,132	88,014,165
1971	137,492	11,376,000	7,236,000	2,804,000	58,606.00	648,045	7,608,741
1972	114,602*	14,254,000	5,586,000	5,738,000	94,492.00	1,243,673	12,731,797
1973-1974				no production			
1975	94,483	11,283,120	15,172,440	---	---	403,754	9,741,155
1976	187,200	24,336,000	28,080,000	---	---	748,800	19,968,957
1971-1976	533,777*	61,249,120	56,074,440	8,542,000	153,098.00	3,044,272	50,050,650
Totals	19,784,501* (ca. 25,500,000)	2,892,885,268	1,185,927,642	107,252,313	1,676,540.25	262,686,843	$593,444,861

1870-1910: Butler, 1920, p. 293

1911-1972: U. S. Bur. Mines Mineral Yearbooks

1975: Utah State Tax Comm.

1976: Rough estimate

Table 34: Production of metals from Summit County, 1870-1976

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1870-1910[1]	?	630,215,000	9,600,000	13,975,000	68,000.00	69,255,000	$83,478,039
1911-1920	1,672,617	262,917,153	20,891,477	10,494,539	37,529.73	24,888,680	34,603,106
1921-1930	3,002,508	376,400,435	76,438,689	11,377,818	40,172.33	29,206,500	52,245,700
1931-1940	1,105,270	215,893,880	136,798,858	5,572,498	25,617.91	14,686,666	26,206,595
1941-1950	2,634,760	168,295,500	129,394,900	5,019,700	27,224.00	10,315,932	40,309,993
1951-1960	1,492,551	89,534,900	97,635,000	2,767,900	102,236.00	6,408,164	33,095,166
1960-1970		89,344,400	98,198,779	2,343,400	245,633.00	5,276,122	34,799,364
1971	13,138	1,796,000	174,000	24,000	149.00	71,382	660,176
1972	?	7,192,000	4,406,000	2,992,000	46,578.00	623,649	6,202,517
1973-1974				no production			
1975	94,483	11,283,120	15,172,440	---	---	403,754	9,741,155
1976	187,200	24,336,000	28,080,000	---	---	748,800	19,968,957
Totals:	(incomplete)	1,877,208,388	618,398,143	54,566,855	593,139.97	161,884,649	$341,310,768

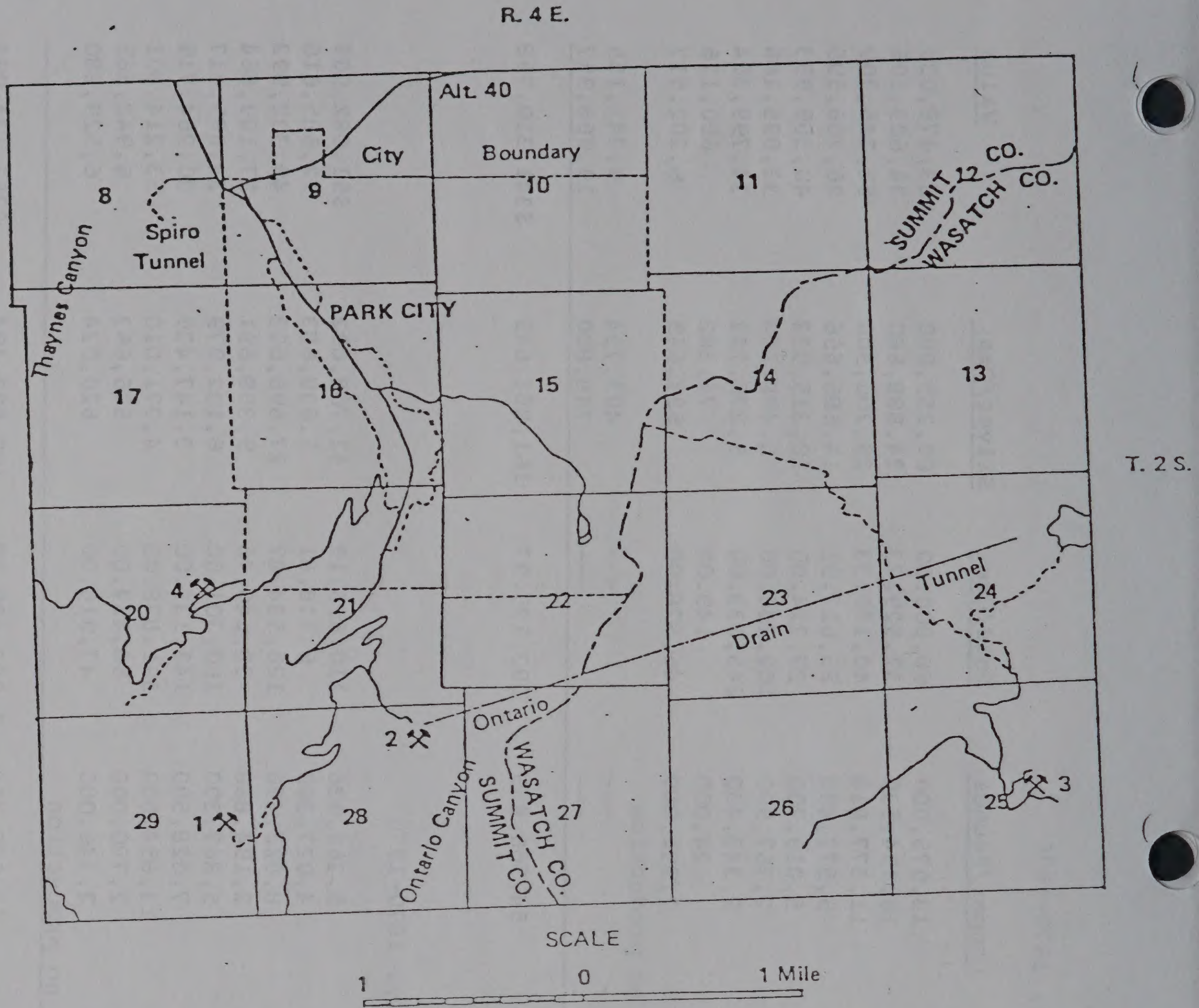
[1] Estimated out of Park City district figures

Table 35: Production of metals from Wasatch County, 1870-1976

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1870-1910[1]	?	342,049,146	13,730,131	5,364,936	110,695.19	42,708,092	$51,082,939
1911-1920	576,646	88,627,027	30,122,512	4,027,360	6,448.81	5,638,683	12,685,616
1921-1930	2,150,877	258,362,618	181,523,578	8,822,496	126,534.82	27,698,623	49,332,992
1931-1940	781,728	75,118,585	68,594,578	2,194,866	38,640.46	9,308,691	17,189,864
1941-1950	731,757	69,925,100	77,486,200	5,867,300	160,701.00	6,132,979	24,885,317
1951-1960	723,505	61,386,404	99,616,500	7,028,500	142,131.00	3,147,429	30,264,719
1961-1970	1,101,531	103,566,000	89,822,000	13,854,000	391,878.00	4,971,010	53,214,801
1971	124,354	9,580,000	5,454,000	2,780,000	58,457.00	576,663	6,948,565
1972	114,604	7,062,000	1,180,000	2,746,000	47,914.00	620,024	6,529,280
1973-1976				no production			
Totals	(incomplete)	1,015,676,880	567,529,499	52,685,458	1,083,400.28	100,802,194	$252,134,093

[1] Estimated out of Park City district figures

1870-1910: Butler, 1920, p. 293
1911-1972: U. S. Bur. Mines Mineral Yearbooks
1975: Utah State Tax Comm.
1976: Rough estimate



PARK CITY DISTRICT

1. Daly West mine
2. Ontario mine
3. Mayflower mine
4. Silver King mine

Figure 129: Park City district location map

Adapted From: USGS Brighton 7½' Quadrangle
USGS Heber City 7½' Quadrangle
USGS Park City East 7½' Quadrangle
USGS Park City West 7½' Quadrangle

continuously since then, only in 1973 and 1974 was there no production. The principal producing mines were the Daly-West, Silver King, Mayflower (New Park), and the Ontario. The latter is the only operating mine in the district today (1977). The production of these and a few others is given in table 36. Numerous mines have operated in the district, but have been consolidated over the years and are now largely owned by one company, United Park City Mines. At present the Ontario property is leased an ASARCO and Anaconda Co. partnership known as Park City Ventures. The Anaconda Co. has a 60 percent investment and ASARCO has 40 percent. United Park City Mines Co. receives a one-third royalty on profits after the initial investment is recovered (White, 1976, p. 67). The company was formed in 1953 when Park Utah Consolidated Mines Co. merged with Silver King Coalition Mining Co. The consolidation of the properties has facilitated exploration and mining of ore, this activity is expected to continue for some time.

The geology of the district is complex with an important anticline, thrust faults, and several large intrusive masses (figure 130). The exposed sedimentary rocks range in age from Mississippian to Triassic. The oldest exposed unit is the early Mississippian Madison Formation, those bearing mineralization include the Deseret, Humbug, Doughnut, Weber, Park City, and Thaynes Formations (figure 131). The igneous rocks can be subdivided into three distinct types: diorite, diorite porphyry, and extrusive andesite (Barnes, 1968, p. 1110). Igneous rocks make up one-third of the rock exposures of the district. The diorite porphyry has the largest outcrop area with exposures in the southern and eastern parts of the district. The diorite crops out only in the southwest corner forming rugged ridges, while the andesite extrusives are found in the northeast corner.

The structure is characterized by folding, thrusting, faulting, and fissuring. The most noted fold in the district is the Park City anticline, **striking north-south, the axis of which lies immediately to the east of the**

Table 36:

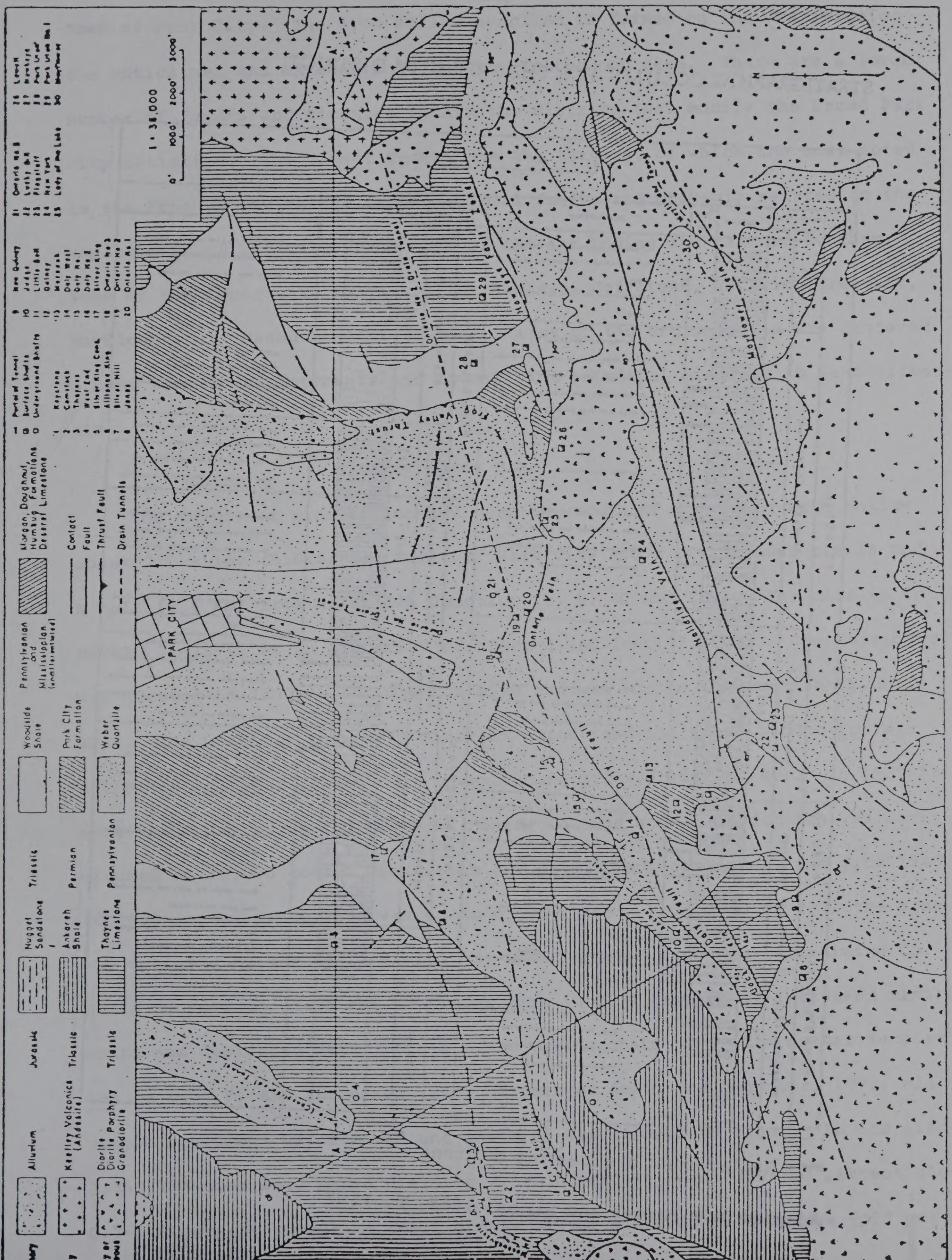
PARK CITY DISTRICT
Total Production 1875 through 1967

Mine	Years	Tons	Oz. Gold	Oz. Silver	Lbs. Lead	Lbs. Zinc	Lbs. Copper
Ontario	1875-1967	2,509,721	46,862	58,964,880	199,091,401	257,432,608	4,741,984
Ave. Grade			0.0535	22.70	3.97	5.13	0.134
Silver King	1882-1967	4,698,609	200,224	88,126,781	1,334,765,435	331,859,041	45,801,007
Ave. Grade			0.0235	18.33	14.20	3.53	0.487
Daly	1886-1950	554,088	18,717	12,734,946	11,166,664	10,877,183	371,628
Ave. Grade			0.0298	22.90	1.00	0.98	0.003
Daly West & Judge	1899-1968	4,265.346	79,051	51,264,289	744,384,966	401,616,365	31,831,461
Ave. Grade			0.0540	12.02	8.73	4.71	0.373
Park Utah	1920-1951	1,238,778	168,264	21,690,467	104,032,694	136,311,084	6,003,021
Ave. Grade			0.0736	17.51	4.20	1.33	0.242
Park City Consolidated	1929-1942	532,155	30,598	8,764,593	20,966,691	32.993,610	Unknown
Ave. Grade			0.0575	16.47	1.97	3.10	?
Mayflower	1936-1967	2,012,204	635,564	11,644,403	214,902,534	251,873,927	27,219,133
Ave. Grade			0.0317	5.79	5.34	6.26	0.678
Total	1875-1967	15,810,901	1,179,280	249,190,289	2,629,310,385	1,422,963,818	115,958,214
Ave. Grade			0.0414	15.76	8.31	4.50	0.367

Source: Erickson, A. J., 1968, Utah Geol. Soc. GB 22, p. 2

Figure 130:

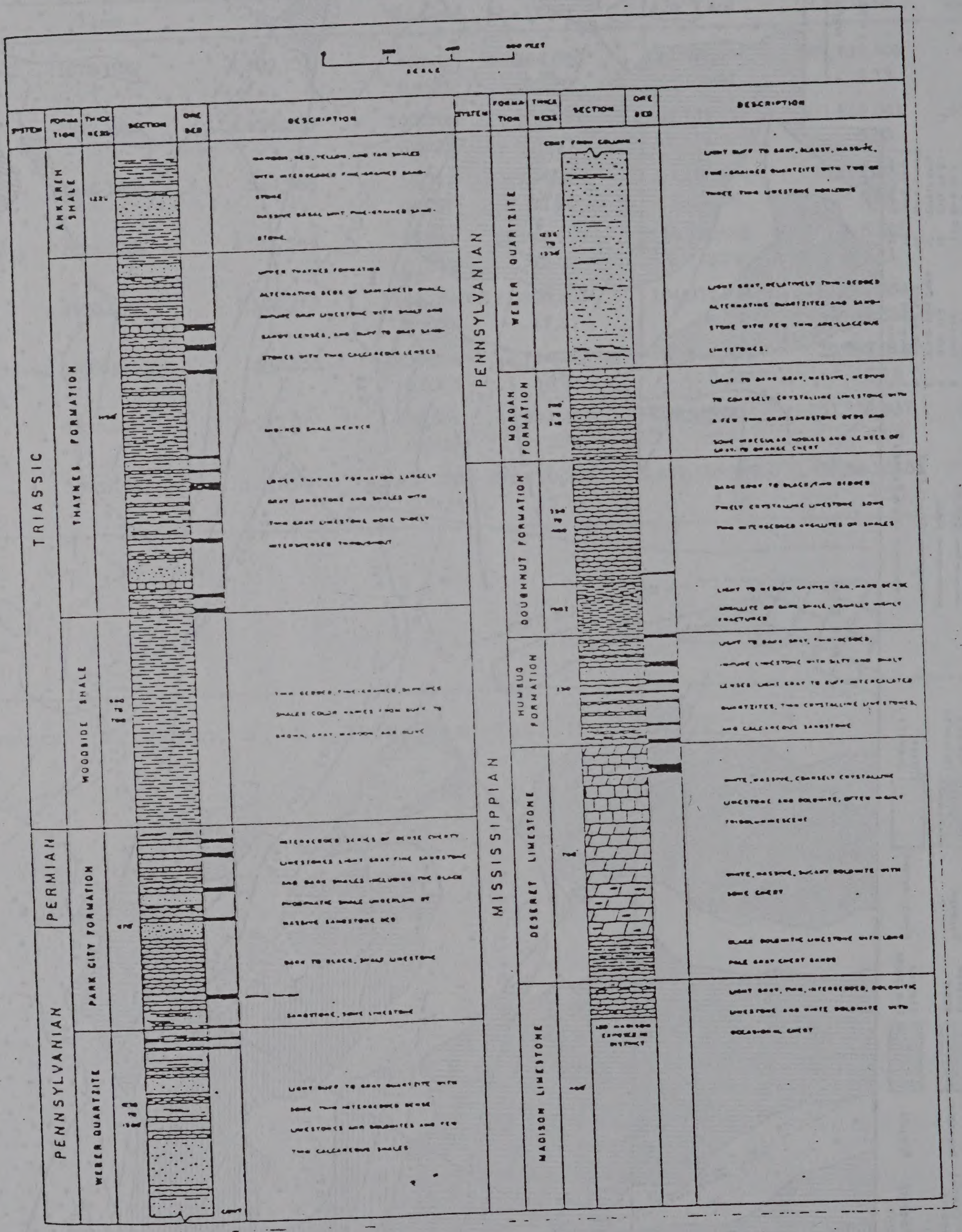
Surface geologic map, Park City District, Utah



Source: *Ore Deposits in the United States 1933/1967*, Vol. 2, Ch. 53—"Ore Deposits of the Park City District with a Contribution on the Mayflower Lode," AIME, 1968.

Figure 131:

STRATIGRAPHIC COLUMN FOR THE PARK CITY DISTRICT



▬ Replacement ore-bearing horizons

Adapted from Barnes and Simos, 1968, p. 1107

town of Park City. The Iron Hollow syncline is formed on the west side of the anticline, and extends into the Big Cottonwood area. There are a large number of faults and fissures within the district that modify the broad Park City anticline. The oldest faults are the thrusts, of which the most noted is the Frog Valley thrust fault. Normal faults are probably related to the emplacement of intrusives and most of the ore bodies are related to them. Some of the important faults are the Hawkeye, Jefferson, Ontario, Crescent, Mayflower, and Massachusetts-McGregor; most of the ore deposits are centered around them as replacements and lodes. The principal ore type is lead-silver-zinc.

Mayflower Mine

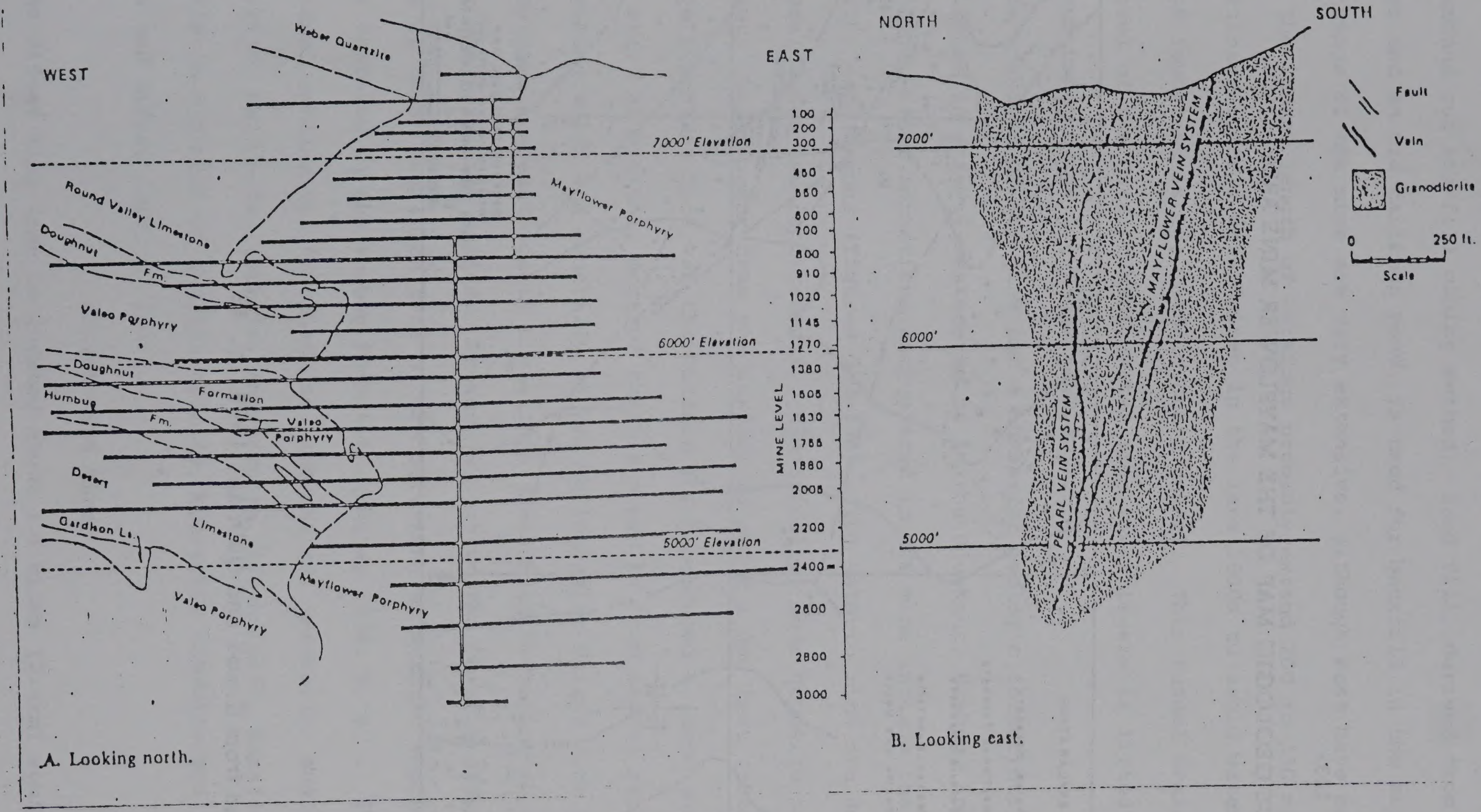
The Mayflower mine is located near the mouth of Big Dutch Pete Hollow about 3.5 miles (5.6km) southeast of Park City and a little over a mile and a half (2.4 km) from Hailstone Junction (U. S. 40 and 189). The mine is in NWNWSE 25-2S-4E at an elevation of about 6,440 feet (1,963m). The Mayflower was located in 1873 as the Glencoe mine and was worked intermittently until 1932. The workings then were minor in extent and the total production was estimated at about 35,000 tons (Quinlan and Simos, 1968, p. 40). In 1932 the mine was acquired by the New Park Mining Co. and annual production was increased to 15,000 tons. Production and development continued, and from 1940 to 1960 annual production was up to 65,000 tons. From 1960 to 1972 the mine was operated by the Hecla Mining Co. under a lease from New Park Mining Co. Hecla decided to close the Mayflower mine in 1972 because of increased mining costs and depressed metal prices. The mining costs rose with hotter temperatures (up to 140° F) and increased water volumes at depth; in December, 1972, all usable equipment was removed and the mine was allowed to flood. In its life 2,354,260 tons were mined yielding 4.5-5.6 percent lead, 3.9-7.0 percent zinc, 0.7-0.8 percent copper, 4.8-6.5 ounces silver and 0.28-0.46 ounces gold per ton.

The majority of the ore is in veins in the Mayflower porphyry. Only a small amount of ore was mined from the sedimentary rocks, although the workings cross many formations, including the Doughnut, Valeo, Humbug, Deseret, Gardison (Madison), and Morgan Formations (figure 133). The workings of the Mayflower are on the east flank of the Park City anticline. The ore is generally found in fissures, the most important being the Mayflower vein. Others include the Pearl, Pearl Split, and the Number Three. The ore minerals include galena, pyrite, sphalerite, chalcopyrite, hematite, rhodochrosite, rhodonite, quartz and gypsum.

Ontario Mine

The Ontario mine is located 1 1/2 miles (2.4km) south of Park City. The main operating shaft, the Ontario No. 3, is in the middle of the west side of Ontario Canyon in SWSWSE 21-2S-4E at an elevation of 7,874 feet (2,400m). The Ontario lode was discovered by Rector Steen in 1872. An outcrop of silver chloride ore was discovered by accident when he struck a piece of loose rock with his foot, whereupon he placed a claim on the site. The claim sold shortly thereafter to developers and work was begun. The first significant production was made in 1873. Thereafter the mine was worked on an intermittent basis as fluctuations in metal prices forced the mine to close on several occasions. Over the years the Ontario mine has been owned by several companies. Higher mining costs, large capital outlays and reduced metal prices forced consolidation of properties, and the Ontario Silver Mining Co. merged with the Park Utah Consolidated Mines Co. in 1936. In 1953,Park Utah merged with Silver King Coalition Mines Co. to form the present owner, the United Park City Mines Co. Present operation in the mine is by Park City Ventures under a lease established in August, 1970. They began extensive development and exploration for ore. Once a suitable amount of reserves had been located, Ventures began renovation of the No. 3 Ontario shaft and construction of a 700 ton per day concentrator. New production from the mine began in 1975 with the completion of the concentrator

Figure 132: GENERALIZED SECTIONS THROUGH THE MAYFLOWER AND PEARL VEINS



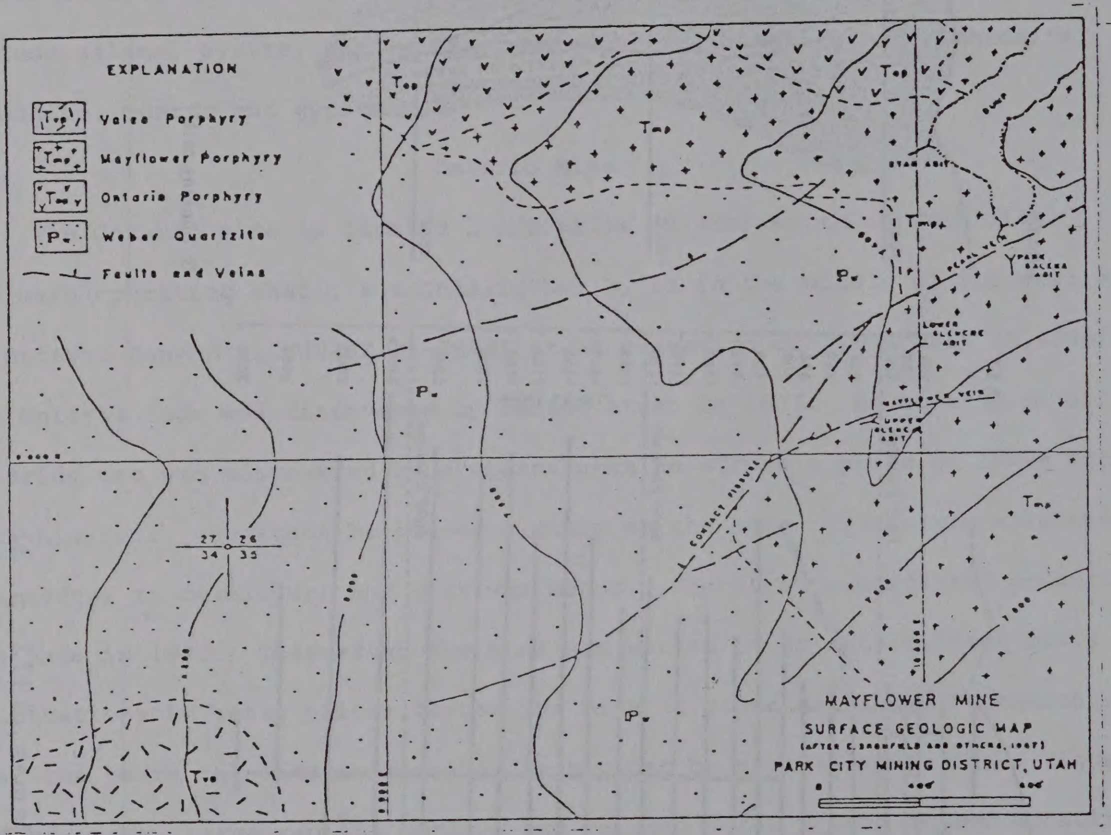
A. Looking north.

B. Looking east.

Adapted from James, 1973, p. 31

Figure 133:

SURFACE GEOLOGIC MAP OF THE MAYFLOWER MINE AREA



Adapted from Simos and Quinlan, 1968, p. 45

and rehabilitation of the shaft. The high angle of ore pockets necessitates the overhand cut and fill mining method. Sand fill, derived from the concentrator tailings and an old tailings pond, is used for backfill in the mined out stopes. The workings of the mine are very extensive, although most have been allowed to cave. The total length of workings probably extend 200 to 350 miles (322-563km). Long drainage tunnels were driven in the late 1800s to avoid water pumping and the most important is the Ontario Drain tunnel. This tunnel drains the 1500-foot level of the Ontario mine, water from lower levels is lifted by pumps having a maximum capacity of 3,200 gpm (200 lps).

The workings of the mine cut a number of geologic formations, but the best ore is found in a few limestone units in the Doughnut, Humbug, and Deseret Limestones. Other formations encountered in the mine include the Weber, Morgan, Park City, and Thaynes (figures 134-136). The Ontario mine ore deposits are of two types; lodes and replacements. Historically, lode deposits have been more important. Lodes occur from the surface to about 1,300 feet (396m) in depth. The most important lode was the Ontario which produced a large amount of rich silver ore. At present, most of the ore mined is from bedded replacement bodies in limestone which are generally higher in lead-zinc values than the lodes. Most replacement ore deposits are within the Humbug Formation in sheet-like to tabular and pipe-like bodies. Present mining in the Ontario draws on a delineated reserve of about 1 million tons of ore occurring as erratic replacement and fissure deposits in the Humbug Formation (White, 1976, p. 67). The ore minerals are galena, sphalerite, tetrahedrite, tennantite, cerussite, anglesite, cerargyrite, malachite, azurite, chrysocolla, bindheimite, massicot and argentite in a gangue of quartz, calcite, hematite, limonite and pyrite (Barnes and Simos, 1968, p. 1116).

Silver King Mine

The Silver King mine is located about 1.5 miles (2.4km) southwest of Park City in Woodside Gulch. Access to the mine is now through the Spiro

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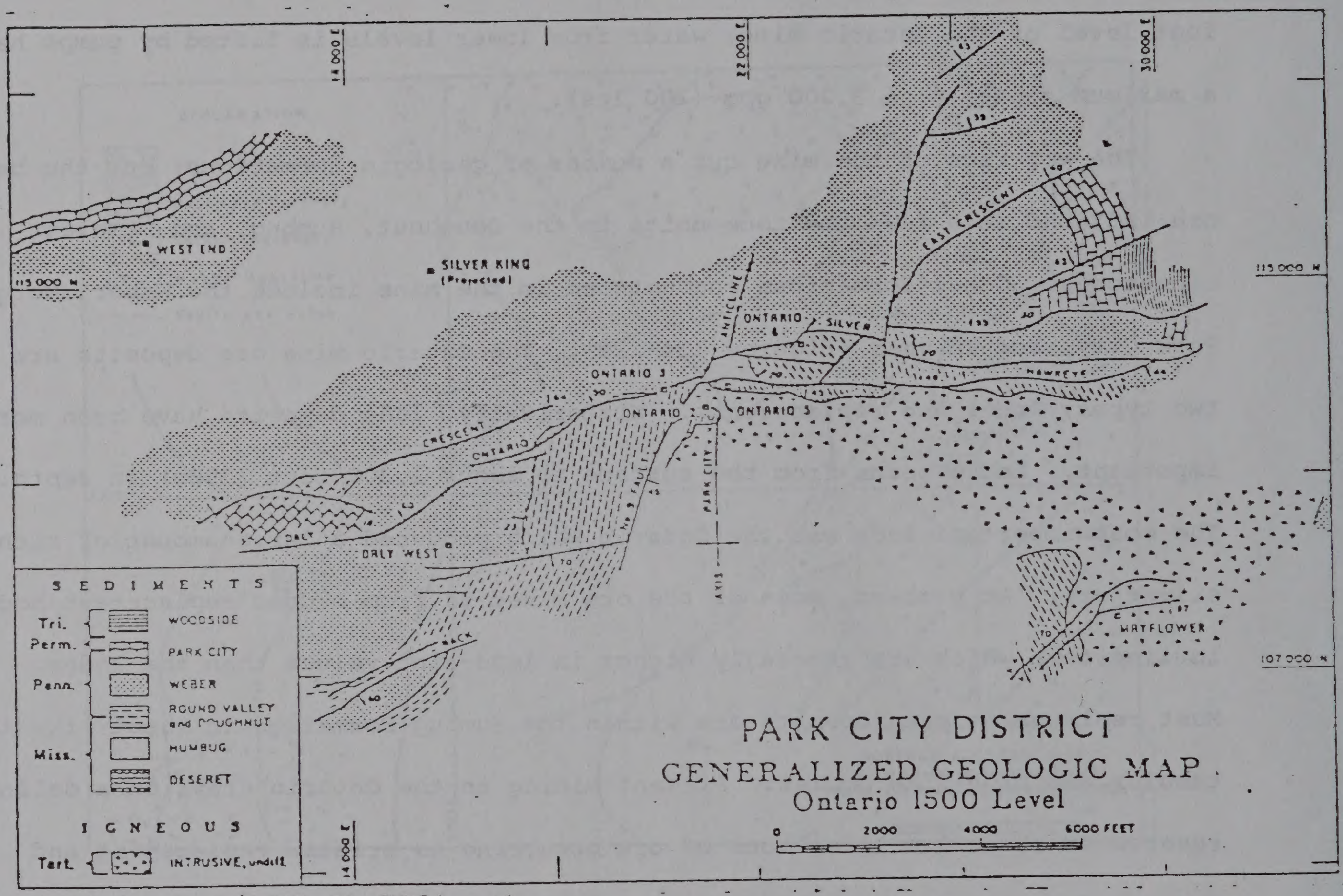
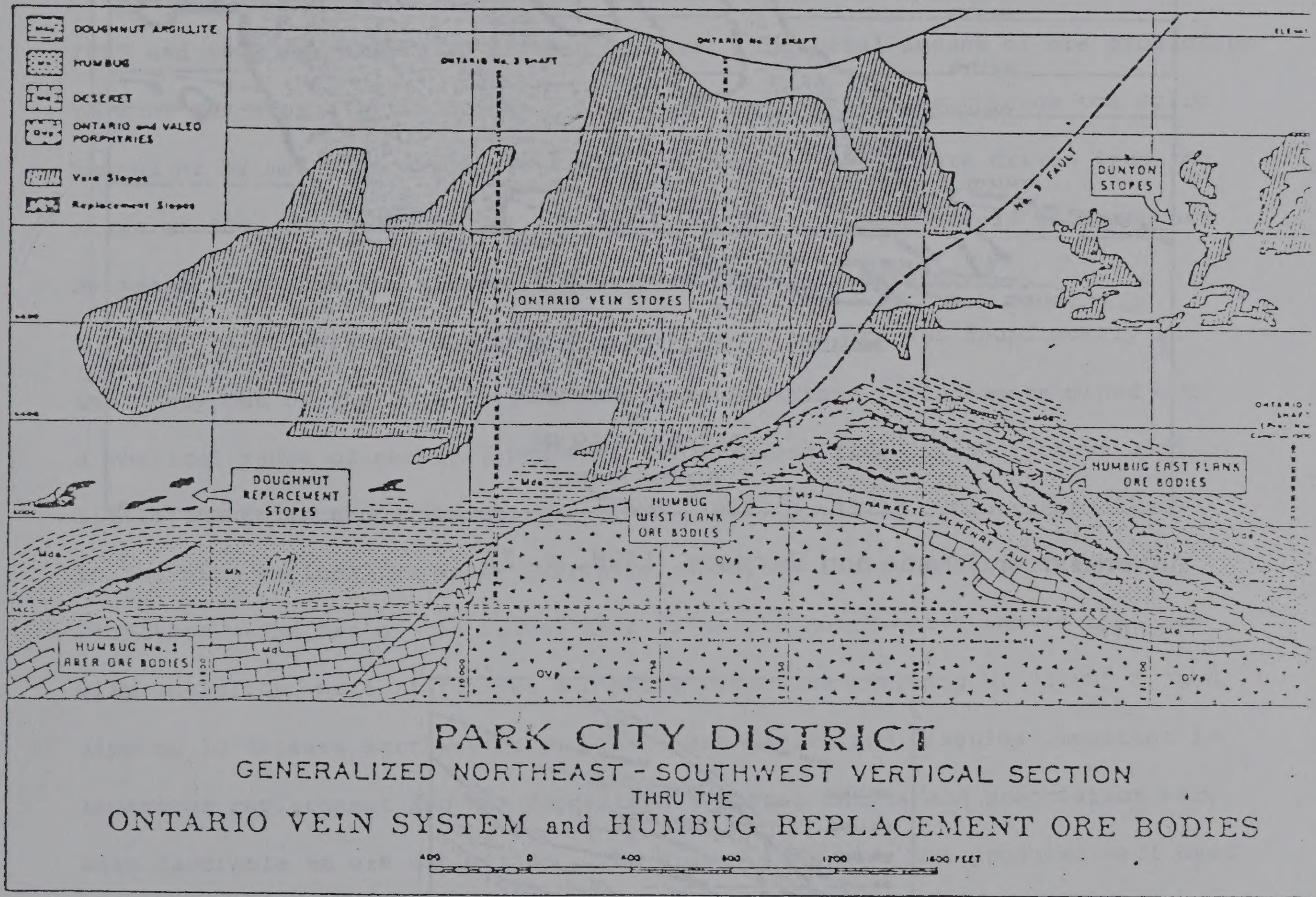
Figure 134:



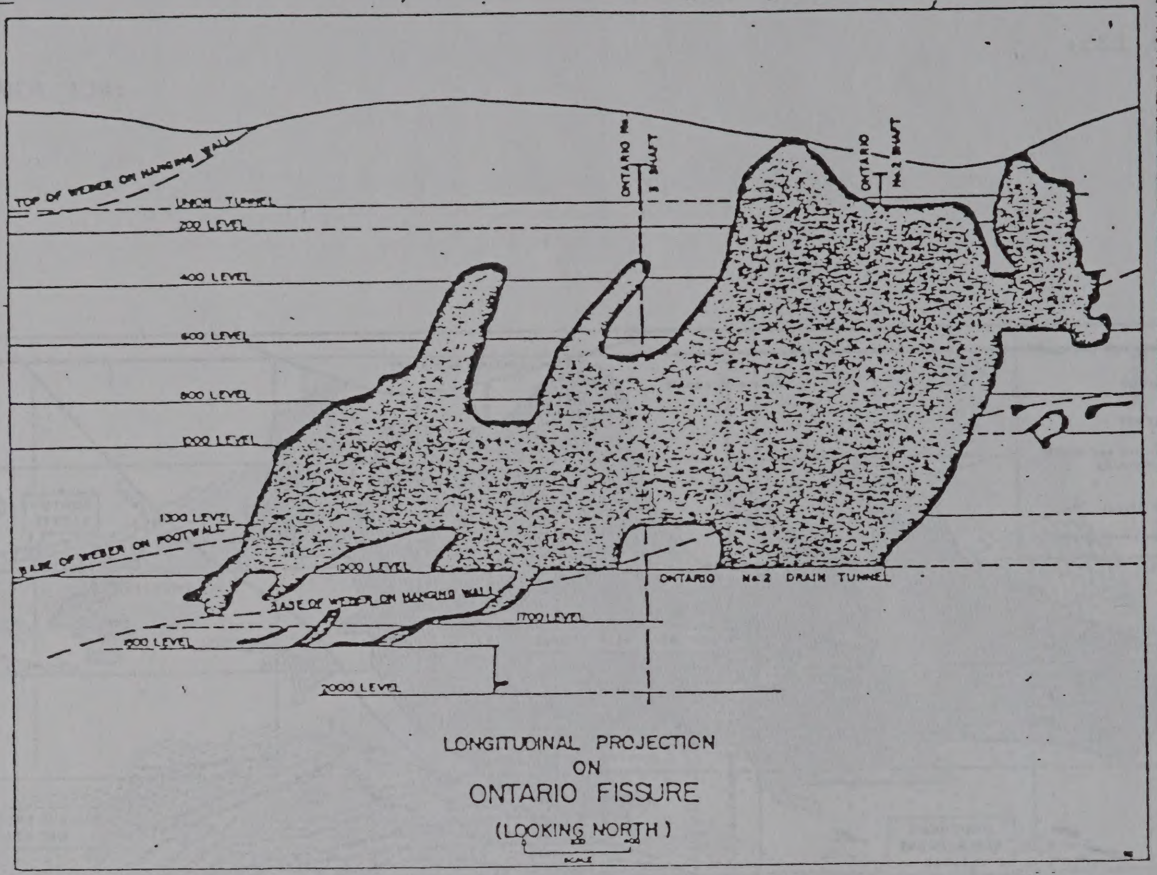
Adapted from Erickson and Garmoe, 1975, figure 2

Figure 135:


DOUGHNUT ARGILLITE
HUMBUG
DESERET
ONTARIO and VALEO PORPHYRIES
Vein Stopes
Replacement Stopes
ONTARIO No. 3 SHAFT
ONTARIO No. 2 SHAFT
ONTARIO VEIN STOPES
No. 3 FAULT
DUNYON STOPES
DOUGHNUT REPLACEMENT STOPES
HUMBUG WEST FLANK ORE BODIES
HUMBUG EAST FLANK ORE BODIES
HAWKEYE - McHENRY FAULT
HUMBUG No. 1 ABER ORE BODIES
OVp
PARK CITY DISTRICT
GENERALIZED NORTHEAST - SOUTHWEST VERTICAL SECTION
THRU THE
ONTARIO VEIN SYSTEM and HUMBUG REPLACEMENT ORE BODIES
400
0
400
800
1200
1600 FEET

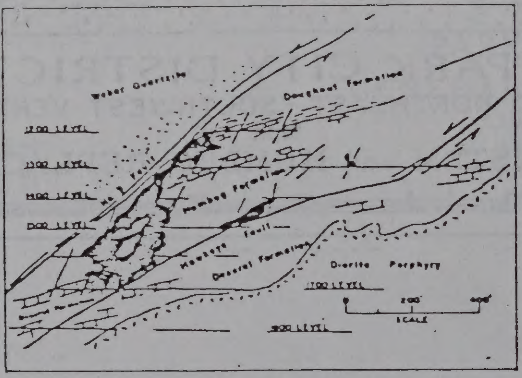
Adapted from Erickson and Garmoe, 1975, figure 5

Figure 136:



Adapted from Garmoe and Erickson, 1968, p. 37

Figure



Cross Section Northwest-Flank Ore Bodies, Ontario Mine.

Adapted from Barnes and Simos, 1968, p. 1124

tunnel portal located immediately northwest of Park City. The tunnel is now being used for a tourist train ride. The old entrance to the Silver King mine is a shaft located in SWSENE 20-2S-4E at an elevation of 8,180 feet (2,493 m). The Silver King mine was located in 1889 by Martin McGrath and W. H. Dodge and in 1892 the operation was incorporated as the Silver King Mining Co. Production of high-grade silver ore began in 1893 and its nets value between 1893 and 1908 was almost 20 million dollars. The total amount of ore production to 1967 was over 4 million tons. Access to the workings is through the Spiro tunnel or by means of the shaft 1,325 feet deep. Levels were driven from the shaft at 300, 700, 800, 900, 1,100 and 1,300 feet. Other levels interconnect by means of raises and winzes; the mine workings are extensive.

The mine workings cut several formations, but ore was found mostly in the Jenny bed of the Park City Formation as limestone replacements mined over a vertical range of nearly 2,000 feet (610m) along five "vein" systems with little change in grade (Barnes and Simos, 1968, p. 1121). Other formations in the mine include the Weber Quartzite, Woodside Shale, and the Thaynes Formation. The ore of the Silver King is on the northwest flank of the Park City anticline where it follows a dipping monocline striking N. 70-80° E. and dipping 20 degrees northwesterly. There are faults and fissures important in limestone replacement and ore deposition. Thrust faults and brecciation were also favorable to ore deposition. The Silver King mine has produced well over four million tons of ore averaging 0.024 ounces gold to the ton, 18.33 ounces silver to the ton, 14.2 percent lead, 0.487 percent copper, and 3.53 percent zinc. The minerals of the mine are galena, tetrahedrite, sphalerite, pyrite, cerussite, anglesite, bindheimite, malachite, quartz and calcite (figure 137).

Daly West Mine

The Daly West mine is located near the head of Empire Canyon, a little over 2.5 miles (4 km) southwest of Park City and is reached by dirt road extending south of the Ontario mine. The shaft house is located in NENESE 29-2S-4E at

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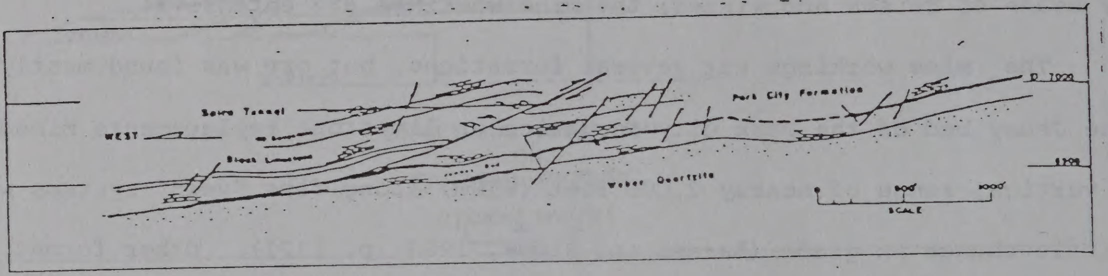
Figure 137:

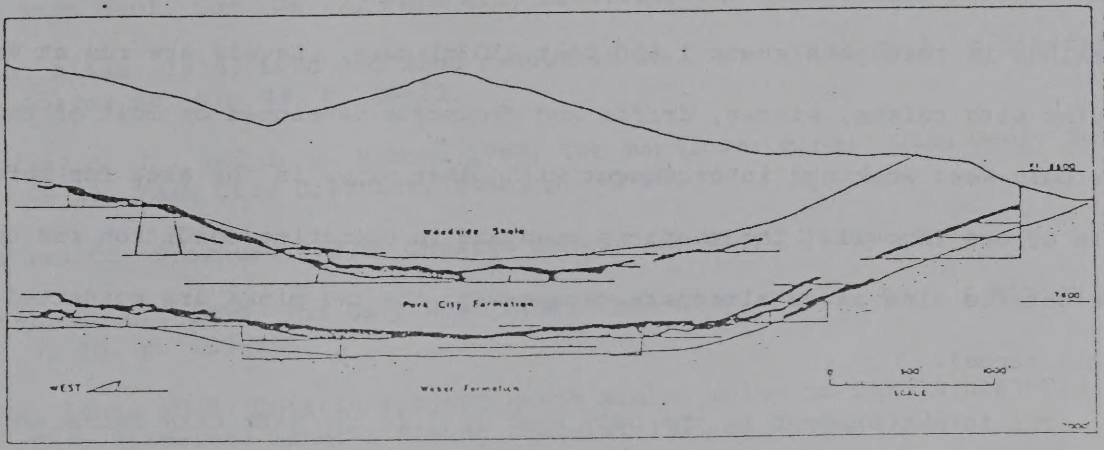
LONGITUDINAL SECTION SILVER KING REPLACEMENT ORE BODIES, SILVER KING MINE



Adapted from Barnes and Simos, 1968, p. 1122

Figure 138:

LONGITUDINAL SECTION MIDDLE VEIN STOPES, JUDGE AND DALY WEST MINES



Adapted from Barnes and Simos, 1968, p. 1120

an approximate elevation of 8,370 feet (2,551m). The Daly West is a consolidated mine and incorporates the Daly Judge mine, Anchor mine, Quincy mine, and Little Bell shaft. The Daly West mine was an outgrowth of the Ontario discovery, prospecting in Empire Canyon went on with the hope of discovering the westward extension of the Ontario lode. Production began in 1891, and operations proceeded intermittently for several years thereafter reflecting the fluctuating prices of silver and lead. Daly West production was very high in the early days of mining. The value from 1892 to 1906 was $11, 203,420 (Boutwell, 1912, p. 150) and total production from the Daly West has been in excess of 4 million tons. The workings are extensive (over 200 miles) and access to the main workings is through a shaft 1,650 feet (503m) deep. Levels are run at various depths with raises, winzes, drifts and crosscuts developed on most of them. The Daly West workings interconnect with other mines in the area for safety and ease of ore removal. The shaft is open and in operating condition for use by the Ontario mine as an alternate escape-way; the two mines are connected by a drain tunnel.

The formations cut in the Daly West include the Park City Formation, Weber Quartzite, Thaynes Formation, and Woodside Shale. The majority of ore occurs as replacement deposits in the Park City Formation along the axis of a broad syncline (figure 138). The Park City ore in the Daly West mine is controlled by several faults or fault zones. These zones provided conduits for ore solutions to reach favorable limestone beds. The four ore zones in the Park City Formation are called (from north to south) Roll vein, Middle vein, Back vein, and 1240 vein; each had high silver, lead, and zinc values. Minerals in the Daly West are galena, tetrahedrite, sphalerite, malachite, azurite, anglesite pyrite, quartz and calcite.

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TOOELE COUNTY

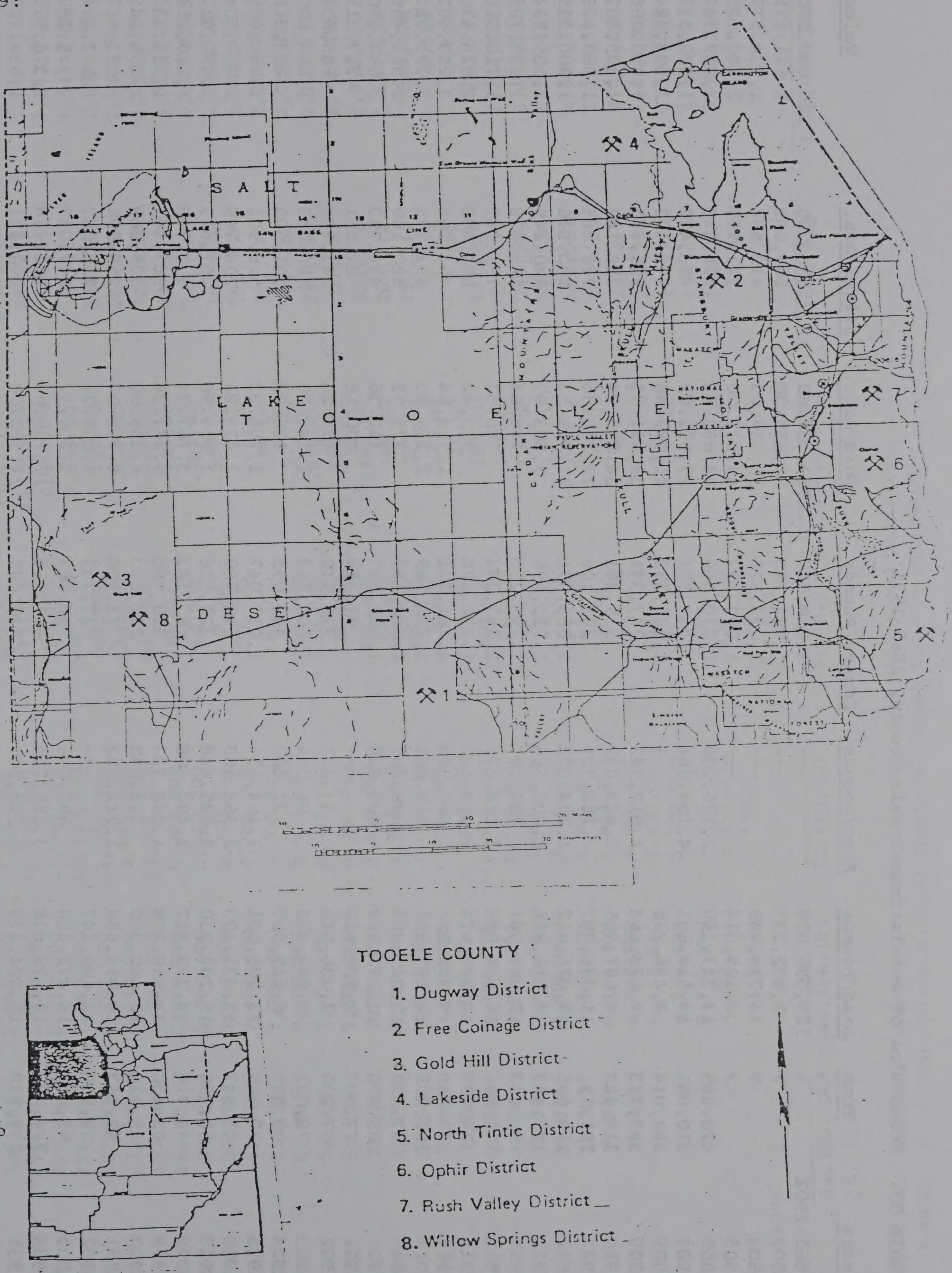
Tooele County has 8 lead-zinc mining districts with a history extending from 1865 to the present. These metals were produced together with gold, silver, copper, and tungsten. Production was continuous from about 1900 to 1972; presently there are no active mines. Tooele County is located in the western part of Utah in the northern third of the state and is surrounded by Box Elder, Davis, Salt Lake, Utah, and Juab Counties. Nevada forms its western boundary. Its mining districts are aligned along its eastern and southern borders (figure 139). The produced lead amounts to 422,578 tons, which at the time of production was valued at $57,578,841. The produced zinc amounts to 136,242 tons valued at $27,848,675. The annual production of these metals in the county along with the gold, silver, and copper is listed in table 37.

Lead and zinc districts that have produced are listed in order of importance: Ophir, Rush Valley, Gold Hill, North Tintic, Dugway, Lakeside, Free Coinage, and Willow Springs. The districts with the greatest potential for future production are Ophir, Rush Valley, Gold Hill, North Tintic and Dugway.

Dugway District

The mines of the Dugway district are located on the northwestern slopes of the Dugway Range approximately 54 miles (87km) northwest of Delta and about 58 miles (93km) west of Eureka. The first discovery within the district was made in 1869 by Sam Gilson on the Buckhorn claim (Staatz and Carr, 1964, p. 165). Lead-zinc-silver ore was mined sporadically, only small tonnages were produced prior to 1934. The total production after 1934 is estimated at 12,000 short tons of ore containing an average grade of 7.7 percent lead, 10.0 percent zinc, 0.07 percent copper, and 1.4 ounces silver to the ton, along with trace amounts of gold. The district has produced at least 2,908,900 pounds of lead and 2,913,700 pounds of zinc (table 38). A topographic map

Figure 139: LOCATION MAP OF TOOELE COUNTY MINING DISTRICTS



TOOELE COUNTY

1. Dugway District
2. Free Coinage District
3. Gold Hill District
4. Lakeside District
5. North Tintic District
6. Ophir District
7. Rush Valley District
8. Willow Springs District

Table 37: Production of metals from Tooele County, 1865-1976

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1865-1902	?	125,000,000	---	2,000,000	550,000.00	7,500,000	$25,000,000
1903	?	2,832,237	---	984,295	56,559.00	263,682	1 571,375
1904	?	14,774,769	---	1,023,825	36,757.00	418,584	1,734,577
1905	?	8,205,814	---	1,093,197	44,821.00	327,556	1,766,505
1906	420,085	13,347,160	2,176,200	1,570,689	44,633.58	358,813	2,359,742
1907	310,801	13,518,601	4,154,988	739,521	27,612.02	468,472	1,989,512
1908	382,014	8,438,295	---	1,067,292	41,969.96	378,373	1,563,424
1909	393,725	7,623,664	1,817,542	747,341	39,691.01	281,713	1,490,096
1910	314,482	8,607,706	2,843,032	315,281	34,895.84	189,143	1,395,802
1911	291,131	11,746,797	253,781	293,106	28,295.36	276,485	1,550,479
1912	268,605	19,025,412	1,234,092	1,065,498	21,799.33	540,816	1,900,365
1913	147,483	14,619,866	1,202,568	1,522,596	9,803.87	640,249	1,535,994
1914	96,593	12,967,981	752,097	1,295,288	796.64	555,038	1,039,785
1915	111,891	16,604,954	1,198,172	2,257,204	746.57	732,083	1,710,616
1916	124,695	18,727,671	2,519,172	2,836,678	913.42	884,403	2,928,420
1917	132,048	15,031,521	1,306,974	4,181,231	1,564.64	793,265	3,253,492
1918	102,305	14,197,551	517,600	2,531,769	1,146.63	691,175	2,395,353
1919	87,339	12,311,455	398,355	1,512,157	775.55	520,169	1,561,469
1920	105,826	10,272,259	807,849	1,203,677	492.36	498,393	1,662,120
1921	17,487	2,538,512	---	97,354	400.16	82,251	217,315
1922	57,230	7,036,516	43,951	776,919	475.24	341,188	845,409
1923	78,021	9,874,472	96,965	1,000,562	1,143.20	478,033	1,260,509
1924	90,885	6,615,007	22,860	403,093	826.92	331,989	823,018
1925	75,559	13,288,081	1,164,551	1,037,047	1,756.83	516,901	1,786,876
1926	40,547	11,071,103	2,368,563	179,780	2,478.83	204,749	1,267,504
1927	68,790	15,207,230	4,045,448	229,816	3,906.96	287,613	1,490,912
1928	48,716	14,773,417	1,494,868	167,143	3,767.74	273,768	1,210,154
1929	62,630	23,599,238	1,048,727	329,750	6,541.36	387,441	1,955,732
1930	45,726	20,660,980	715,042	222,670	4,359.99	305,969	1,304,245
1931	49,597	18,054,684	1,211,553	71,908	4,752.07	258,886	893,917
1932	29,508	14,689,147	---	27,733	4,690.29	206,087	597,494
1933	62,955	14,472,264	899,076	98,367	5,286.52	247,057	775,282
1934	224,887	14,323,838	3,556,256	437,963	10,799.06	362,478	1,328,995
1935	277,988	15,224,375	6,295,909	730,602	21,583.00	390,521	1,982,727
1936	247,553	24,492,565	9,857,400	1,056,598	18,828.20	546,634	2,799,090
1937	214,120	19,980,254	12,969,800	1,032,544	17,269.00	439,894	3,168,828
1938	275,995	13,539,370	7,752,583	1,032,102	25,584.00	262,453	2,253,974
1939	557,061	19,210,659	7,293,788	4,285,202	34,251.00	1,006,469	3,609,803

Table 37 continued:

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1940	561,882	21,143,800	7,214,000	2,218,000	38,353.00	904,164	$3,747,433
1941	386,282	12,155,700	7,936,000	505,000	34,872.00	456,629	2,892,899
1942	259,164	11,973,000	15,735,000	477,000	16,349.00	399,247	3,179,414
1943	207,533	10,313,000	18,064,500	320,500	4,352.00	456,795	3,243,258
1944	158,475	7,863,000	12,737,500	280,000	4,685.00	364,680	2,542,218
1945	127,361	6,797,000	15,935,400	149,800	2,159.00	249,435	2,690,277
1946	123,576	8,144,000	13,805,500	574,500	1,807.00	266,370	2,943,508
1947	162,935	9,890,000	13,366,200	667,300	4,089.00	401,957	3,690,589
1948	151,328	10,866,000	8,893,000	981,800	5,217.00	429,870	3,912,589
1949	88,724	8,400,000	6,513,200	714,500	2,769.00	349,502	2,688,825
1950	30,370	4,960,600	3,360,506	419,000	1,367.00	181,022	1,445,703
1951	47,401	7,184,600	4,296,000	190,700	1,159.00	253,767	2,341,194
1952	51,232	7,328,000	3,300,000	336,000	884.00	267,310	2,081,789
1953	65,825	8,490,000	5,454,000	414,000	1,323.00	309,712	2,069,828
1954	59,603	7,806,000	5,092,000	618,000	1,570.00	298,698	2,126,949
1955	54,281	5,960,000	4,382,000	210,000	962.00	207,125	1,726,485
1956	77,620	7,091,400	4,610,800	308,700	2,169.00	310,171	2,232,863
1957	42,158	6,927,100	2,901,400	315,100	548.00	269,212	1,684,812
1958	24,140	3,542,000	1,914	236,000	403.00	159,342	829,408
1959	1,750	180,000	164,000	8,000	129.00	4,270	50,588
1960	2,101	134,000	176,000	14,000	10.00	5,496	48,655
1961	15,525	2,424,000	1,704,000	328,000	101.00	111,094	623,223
1962	31,252	4,858,000	3,550,000	518,000	145.00	225,403	1,264,626
1963	32,339	5,174,000	3,850,000	492,000	145.00	249,943	1,472,531
1964	27,770	4,600,000	3,256,000	432,000	120.00	220,826	1,476,413
1965	28,297	4,404,000	3,306,000	354,000	130.00	198,037	1,555,375
1966	39,613	6,132,000	4,364,000	538,000	163.00	271,123	2,110,570
1967	38,395	6,882,000	4,356,000	356,000	154.00	235,999	2,073,639
1968	?	5,198,000	3,430,000	262,000	167.00	168,255	1,627,000
1969	?	4,270,000	3,180,000	280,000	123.00	162,352	1,529,000
1970	?	2,780,000	1,936,000	266,000	127.00	134,466	1,126,818
1971	?	4,602,915	3,462,172	430,937	200.00	192,057	1,729,220
1972	?	176,654	130,753	25,903	---	9,291	75,959
1973-1976				no production			
	11,380,000* (8,711,210)	845,156,194	272,483,607	55,665,538	1,238,724.95	31,972,413	$153,814,568

1865-1902: Estimate based on published reports and historical activity
1903-1976: U. S. Bur. Mines Mineral Yearbooks (some figures estimated)

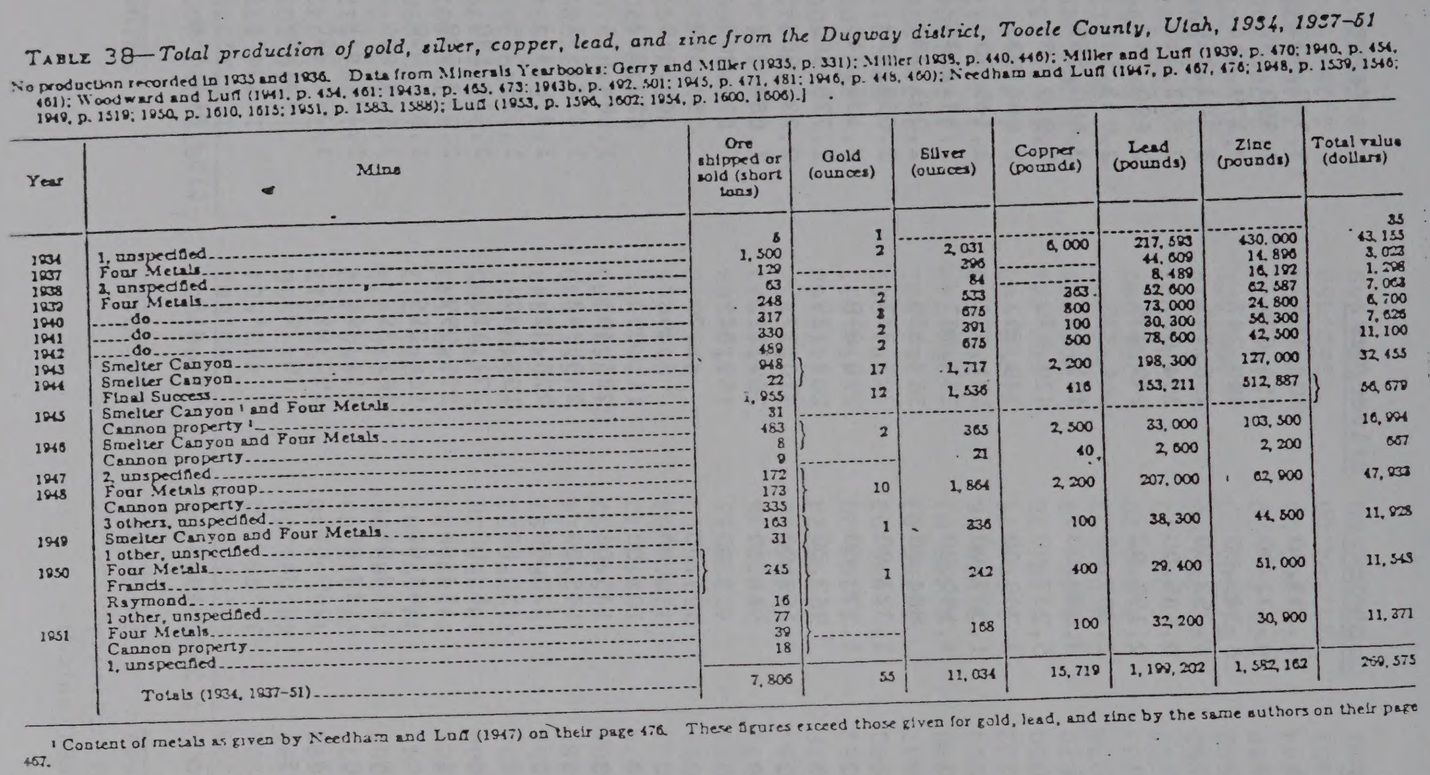


Table 38—*Total production of gold, silver, copper, lead, and zinc from the Dugway district, Tooele County, Utah, 1934, 1937–51*

No production recorded in 1935 and 1936. Data from Minerals Yearbooks: Gerry and Miller (1935, p. 331); Miller (1938, p. 440, 446); Miller and Luff (1939, p. 470; 1940, p. 454, 461); Woodward and Luff (1941, p. 454, 461; 1943a, p. 465, 473; 1943b, p. 492, 501; 1945, p. 471, 481; 1946, p. 448, 460); Needham and Luff (1947, p. 467, 476; 1948, p. 1539, 1546; 1949, p. 1519; 1950, p. 1610, 1615; 1951, p. 1583, 1588); Luff (1953, p. 1596, 1602; 1954, p. 1600, 1606).]

Year	Mine	Ore shipped or sold (short tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)	Total value (dollars)
1934	1, unspecified	6	1					35
1937	Four Metals	1,500	2	2,031	6,000	217,593	430,000	43,155
1938	1, unspecified	129		296		44,609	14,896	3,023
1939	Four Metals	63		84		8,489	16,192	1,298
1940	do	248	2	533	363	52,600	62,587	7,063
1941	do	317	3	675	800	73,000	24,800	6,700
1942	do	330	2	391	100	30,300	56,300	7,626
1943	Smelter Canyon	489	2	675	500	78,600	42,500	11,100
1944	Smelter Canyon	948	17	1,717	2,200	198,300	127,000	32,455
	Final Success	22						
1945	Smelter Canyon [1] and Four Metals	1,955	12	1,536	416	153,211	512,887	56,679
	Cannon property [1]	31						
1946	Smelter Canyon and Four Metals	483	2	365	2,500	33,000	103,500	16,994
	Cannon property	8						
1947	2, unspecified	9		21	40	2,600	2,200	667
1948	Four Metals group	172	10	1,864	2,200	207,000	62,900	47,933
	Cannon property	173						
	3 others, unspecified	335						
1949	Smelter Canyon and Four Metals	163	1	236	100	38,300	44,500	11,928
	1 other, unspecified	31						
1950	Four Metals	245	1	242	400	29.400	51,000	11,543
	Francis							
	Raymond							
	1 other, unspecified	16						
1951	Four Metals	77		168	100	32,200	30,900	11,371
	Cannon property	39						
	1, unspecified	18						
	Totals (1934, 1937–51)	7,806	55	11,034	15,719	1,199,202	1,582,162	269,575

[1] Content of metals as given by Needham and Luff (1947) on their page 476. These figures exceed those given for gold, lead, and zinc by the same authors on their page 467.

Source: Staatz and Carr, 1964, p. 166.

1916-1969 totals:

Lead: 2,908,900 pounds
Zinc: 2,913,700 pounds
Copper: 74,700 pounds
Gold: 148 ounces
Silver: 29,326 ounces

Total value: $604,055

showing the locations of the principal lead-zinc mines is given as figure 140.

The rocks of the district range in age from the Cambrian Prospect Mountain Quartzite to the Upper Mississippian Ochre Mountain Limestone (figures 141-142). Some small areas of igneous rhyodacite breccias and tuffs have also been noted. The structures in the district include thrust faults, fault grabens, reverse and normal faults, and folds. Thrusts and faults provided the main conduits for ore deposition. Ore is located in limestones and dolomites in fissure veins and replacements, and in fissure veins in quartzite. The ore bodies are generally small, although usually of high grade. These are scattered and have limited extent, but a potential reserve of 50,000 tons of ore can probably be found in the district.

Bertha Mine

The Bertha mine portal is in SWNWSE 3-10S-12W at an elevation of 5,860 feet (1,786m) at the head of Bertha graben, 1 mile (1.6km) south of the Four Metals mine. The Bertha was located in the 1890s and patented on May 16, 1900. A little copper ore was shipped to the smelter at Stockton at the turn of the Century. Work was done intermittently since that date and the most recent work was done in 1955 when 78 tons of ore were shipped to the American Smelting and Refining Co. The mine workings consist of a shaft 95 feet (29m) deep and an adit from which 400 feet (122m) of drifting and stoping has been done (figure 143). Mineralization in the Bertha is in dolomite, formation unknown, at the southeast end of the Bertha graben. The dolomite is placed against the Cambrian Prospect Mountain Quartzite along both of the graben's faults. Mineralization consists of pyritic copper ore containing minor amounts of lead and zinc replacing the dolomite. Minerals found in the mine are chalcanthite, aurichalcite, galena, cerussite, hemimorphite, smithsonite, covellite, chalcocite, limonite, pyrite, quartz, and gypsum. The mine contains approximately 300 ton of ore averaging 3 percent copper, 0.2 percent lead, and 0.5 percent zinc.

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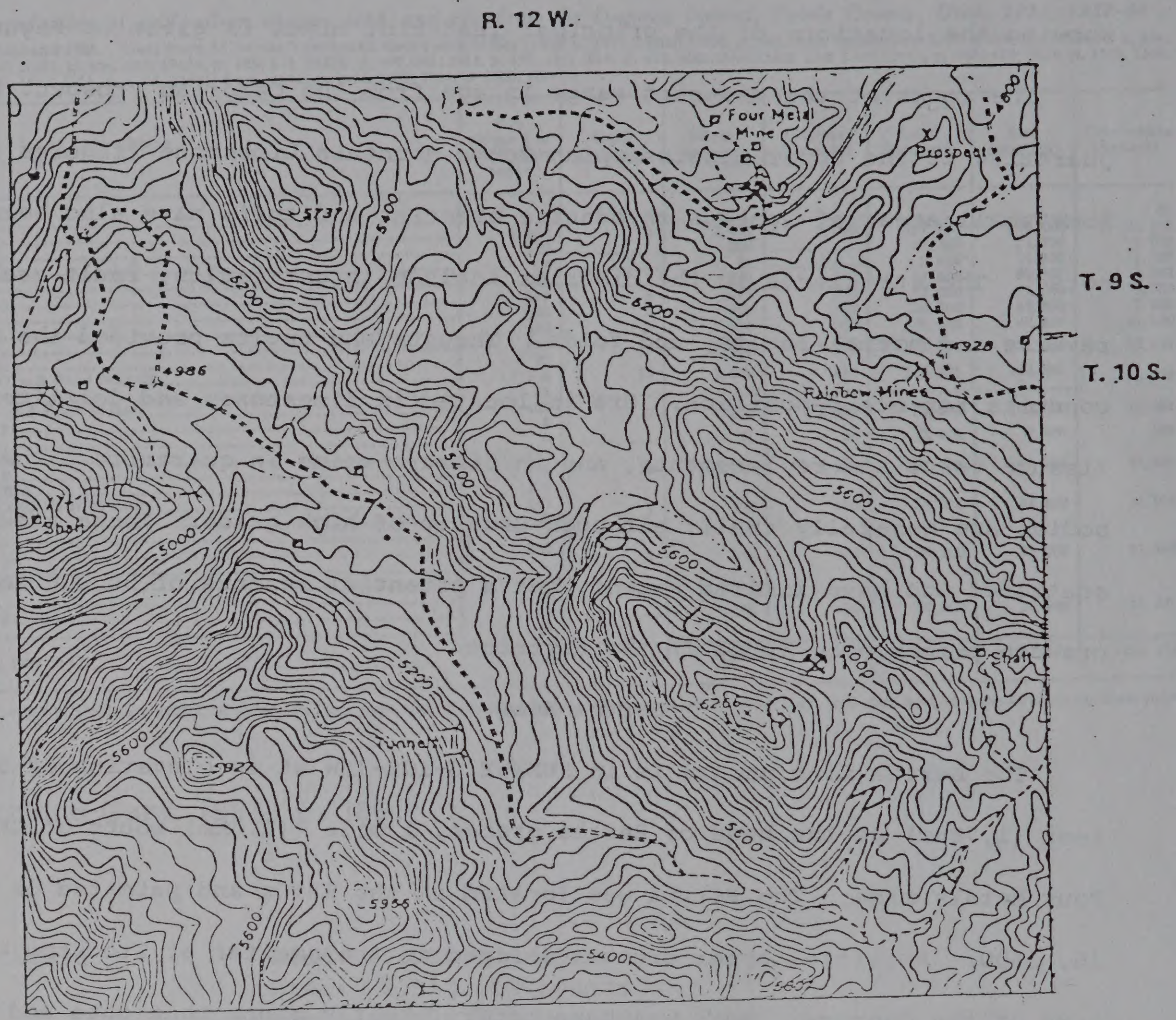
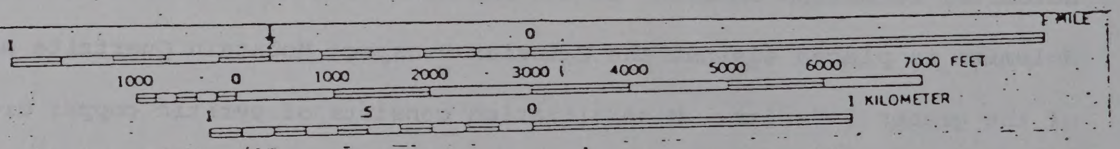


Figure 140: Topographic map of the Dugway mining district

DUGWAY DISTRICT

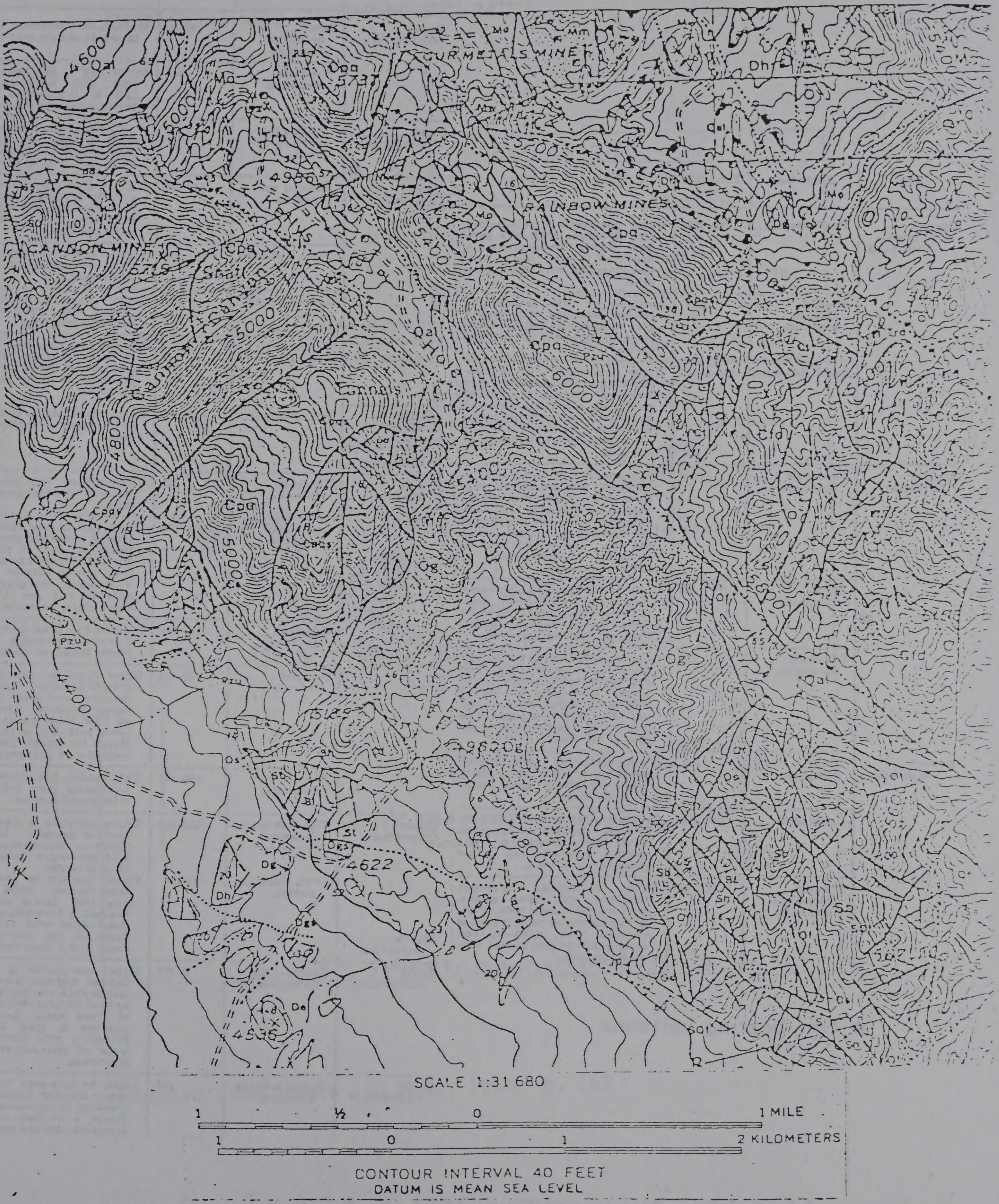
1. Bertha mine
2. Four Metals mine



Adapted From: USGS Dugway Range NW 7½′ Quadrangle

Figure 141:

GEOLOGIC MAP OF THE DUGWAY MINING DISTRICT



Adapted from Staatz and Carr, 1964, plate 1

Figure 142:

STRATIGRAPHIC COLUMN OF THE DUGWAY MOUNTAIN RANGE

Age	Formation	Thickness (feet)	General description
Upper Mississippian.	Ochre Mountain limestone.	470+	Medium-gray limestone with some interbeds of dark-gray dolomite.
	Woodman formation.	785	Upper half is thin-bedded light-gray silty limestone. Lower half is thin-bedded reddish-brown calcareous siltstone.
Lower Mississippian ●	Madison limestone equivalent.	315	Medium-gray limestone with some chert in upper part, and a few beds containing quartz sand in lower part in some places.
— — —?— — — Upper Devonian	Hanauer formation.	480–730	Light- to dark-gray dolomite with a little light-gray limestone at the top, interbedded with brown-weathering gray to white dolomitic quartzite.
	Ofison dolomite.	915–1,310	Light- to dark-gray dolomite with some beds containing numerous *Amphipora*.
	Goshoot formation.	390	Light- to dark-gray dolomite interbedded with brown-weathering dolomitic quartzite.
	Engelmann formation.	2,750+	Massive sandy-textured light-gray to black dolomite with some interbeds of light-gray to black limestone in lower half of the formation.
Middle Devonian — — —?— — — Lower(?) Devonian	Sevy dolomite.	1,120	Fine-grained thin- to medium bedded mouse-gray laminated dolomite.
Middle Silurian	Thursday dolomite.	330	Thick-bedded light-gray sandy-textured medium-grained dolomite.
	Lost Sheep dolomite.	215–270	Upper part is gray dolomite containing numerous small parallel bands of gray or pink chert. Lower and middle parts are light-gray sandy-textured dolomite with some blue-gray mottled dolomite and one thin bed of black cherty dolomite.
	Harrisite dolomite.	110–175	Massive dark-gray sandy-textured dolomite containing numerous poorly preserved *Halysites*.
	Bell Hill dolomite.	340–430	Upper part is light-gray fine-grained dolomite. Lower part is massive dark-gray sandy-textured dolomite. Middle part on Spor Mountain is similar to lower part, but in the Dugway Range the middle part is interbedded with light-gray dolomite.
	Floride dolomite.	100–135	Thin-bedded, fine-grained, smooth-weathering gray dolomite and calcareous dolomite.
— — —?— — — Upper Ordovician	Fish Haven dolomite.	225–310	Upper one-third is massive black mottled dolomite. Lower two-thirds is slope-forming thin- to medium-bedded smooth-weathering dolomite.
Middle Ordovician.	Swan Peak formation.	440–840	Upper one-half to two-thirds is thick-bedded white vitreous quartzite. Lower one-third to one-half is brownish-green shale interbedded with thin beds of hematitic red quartzite, limestone, and a little dolomite.
Lower Ordovician.	Garden City formation.	1,725	Upper one-quarter is gray thin-bedded nodular limestone and tan- to pink-weathering medium-bedded limestone with a few beds of green shale. Lower three-quarters is gray thin-bedded limestone with numerous thin beds of intraformational conglomerate.
Upper Cambrian.	Dugway Ridge dolomite.	885	Light- to dark-gray thick-bedded sandy-textured dolomite, which contains, in the eastern Dugway Range, a few beds of light-gray limestone near the top.

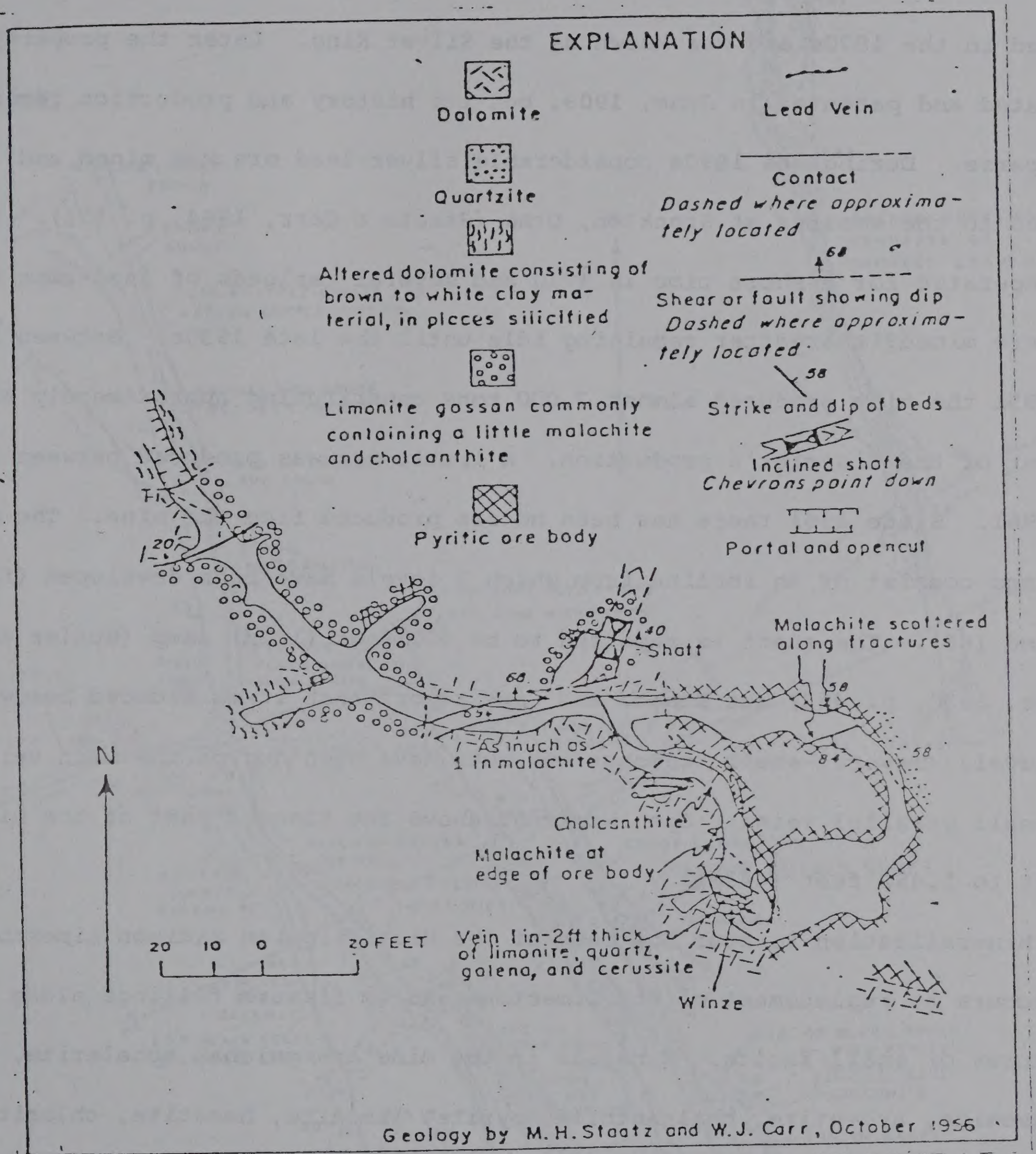
Age	Formation	Thickness (feet)	General description
Upper Cambrian—Continued	Fera limestone.	280–400	Upper one-fourth is thin-bedded gray limestone with silty partings. Lower three-quarters is a light-gray to pink, locally mottled limestone with minor dolomite.
	Straight Canyon formation.	360–390	Medium-gray thin- to medium-bedded limestone with massive gray medium-grained dolomite common, especially in the upper part.
	Lamb dolomite.	865–1,010	Upper one-fourth is reddish-weathering thin-bedded gray limestone with a thin-bedded red-brown calcareous quartzite at the top. Lower three-fourths is massive gray dolomite with a conspicuous zone of *Girvanella* at the base.
Middle Cambrian.	Fandangle limestone.	1,670	Upper one-third is blue-gray thin-bedded to medium-bedded limestone interbedded with white-weathering light-gray laminated limestone with a few thin beds of intraformational conglomerate at the top. Lower two-thirds is blue-gray medium-bedded to massive limestone.
●	Trailer limestone.	385	Upper two-thirds is dark blue-gray thin-bedded argillaceous limestone containing numerous worm trails. Lower one-third is a dark blue-gray massive limestone.
	Shadscale formation.	520	Upper three-fourths is a blue-gray fine-grained limestone interbedded with grayish-green shale. Lower one-fourth is brown-weathering grayish-green micaceous siltstone with orange-brown weathering cream-colored dolomite at the base.
Lower Cambrian.	Busby quartzite.	160	Brown-weathering greenish-gray quartzite overlain by a dark-brown-weathering green micaceous siltstone.
	Cabin shale.	135–145	Brown-weathering green flaggy micaceous siltstone interbedded with brown-weathering white vitreous quartzite and minor greenish-brown shale.
	Prospect Mountain quartzite.	12,000+	White to purple well-bedded quartzite with some quartz-pebble conglomerate beds. Parts of this formation contain beds of greenish shale, siltstone, and shaly quartzite interbedded with gray quartzite.

● Ore-bearing horizons

Adapted from Staatz and Carr, 1964, p. 8 & 9

Figure 143:

GEOLOGIC MAP OF THE BERTHA MINE


EXPLANATION
Dolomite
Quartzite
Altered dolomite consisting of brown to white clay material, in places silicified
Limonite gossan commonly containing a little malachite and chalcanthite
Pyritic ore body
Lead Vein
Contact
Dashed where approximately located
Shear or fault showing dip
Dashed where approximately located
Strike and dip of beds
Inclined shaft
Chevrons point down
Portal and opencut
20
68
40
Shaft
Malachite scattered along fractures
58
84
58
As much as 1 in malachite
Chalcanthite
Malachite at edge of ore body
Vein 1 in-2 ft thick of limonite, quartz, galena, and cerussite
Winze
N
20 10 0 20 FEET

Geology by M.H. Staatz and W.J. Carr, October 1956

Adapted from Staatz and Carr, 1964, p. 168

Four Metals Mine

The Four Metals mine is located near the head of a canyon leading into the district from the east side of the Dugway Range. It is in SENESW 34-9S-12W at an elevation of 5,040 feet (1,536m) above sea level. The property was first located in the 1870s and was known as the Silver King. Later the property was relocated and patented in June, 1909, but its history and production records are sparse. During the 1890s considerable silver-lead ore was mined and shipped to the smelter at Stockton, Utah (Staatz & Carr, 1964, p. 171). The mine operated for a short time in 1910 and several carloads of lead-zinc sulfide ore were mined, thereafter remaining idle until the late 1930s. Between 1937 and 1951 the mine produced almost 7,000 tons constituting approximately 60 percent of the district's production. A little ore was produced between 1951 and 1961. Since 1961 there has been no ore produced from the mine. The mine workings consist of an incline from which 5 levels have been developed (figures 144 and 145). The shaft is reported to be 400 feet (122m) deep (Butler and others, 1920, p. 463) but Staatz and Carr report that it is flooded below the 270 level. Several small trenches and cuts have been dug on the main vein and small parallel veins. Open workings above the flooded part of the mine amount to 1,450 feet (442m).

Mineralization is near the base of the Mississippian Madison Limestone and occurs as replacement of the limestone and as fissure fillings along fractures or small faults. Minerals in the mine are galena, sphalerite, cerussite, smithsonite, argentite, chalcanthite, pyrite, limonite, hematite, chlorite, barite, calcite, quartz and clay. There are no known reserves in the mine, but the possibility of finding additional ore along the same vein is good.

References:

Butler, B. S.and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672p.

Staatz, M. H. and W. J. Carr, 1964, Geology and mineral deposits of the Dugway and Thomas Ranges, Juab and Tooele Cos., Utah: U. S. Geol. Survey Prof. Paper 415, 188p.

Figure 144:

Geologic map of the Four Metals mine

Adapted from Staatz and Carr, 1964, plate 9

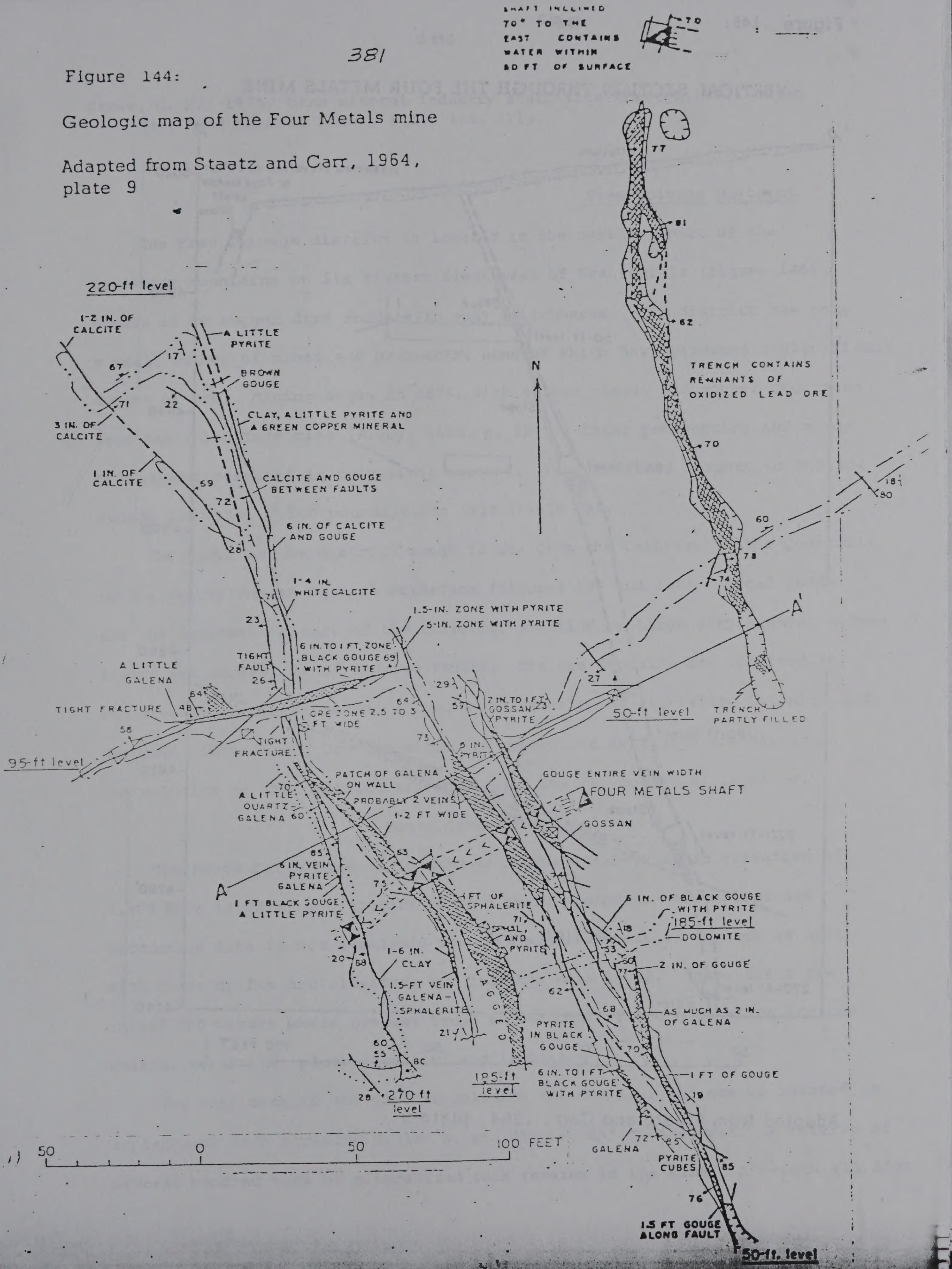
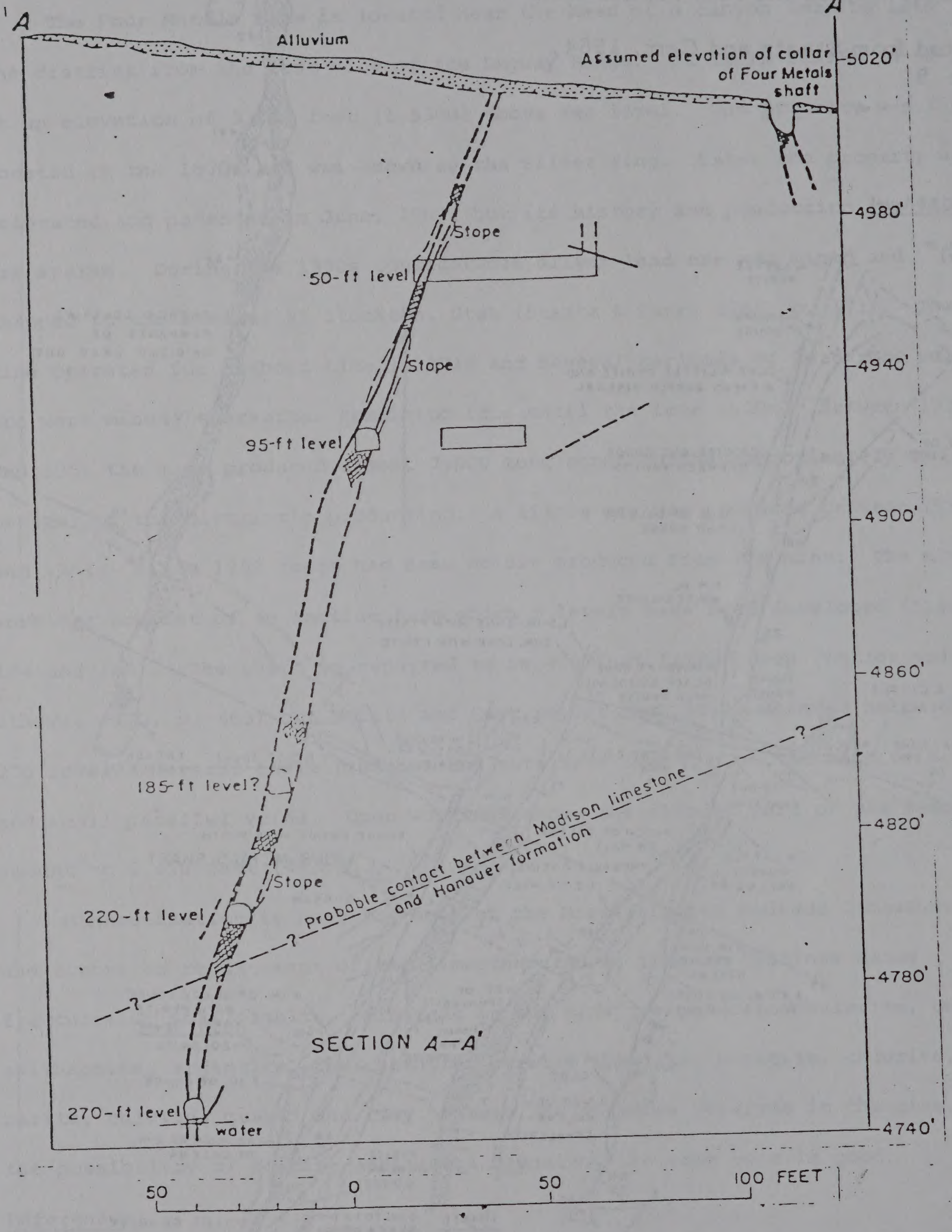


Figure 145: 382

VERTICAL SECTION THROUGH THE FOUR METALS MINE



Adapted from Staatz and Carr, 1964, plate 9

Stowe, C. H., 1975, Utah mineral industry statistics through 1973: Utah Geol. and Mineral Survey Bull. 106, 121p.

Free Coinage District

The Free Coinage district is located in the northern part of the Stansbury Mountains on its eastern flank west of Grantsville (figure 146). Access is by rugged dirt roads with many switchbacks. The district has only a small number of mines and prospects, none of which have produced a significant amount of ore. Mining began in 1875, with silver, lead, and copper ore taken from the Third Term mine (Rigby, 1958, p. 124). Later prospecting and minor development resulted in only minor success. Lead produced amounts to 307,524 pounds and zinc, 7,500 pounds,since 1933 (table 39).

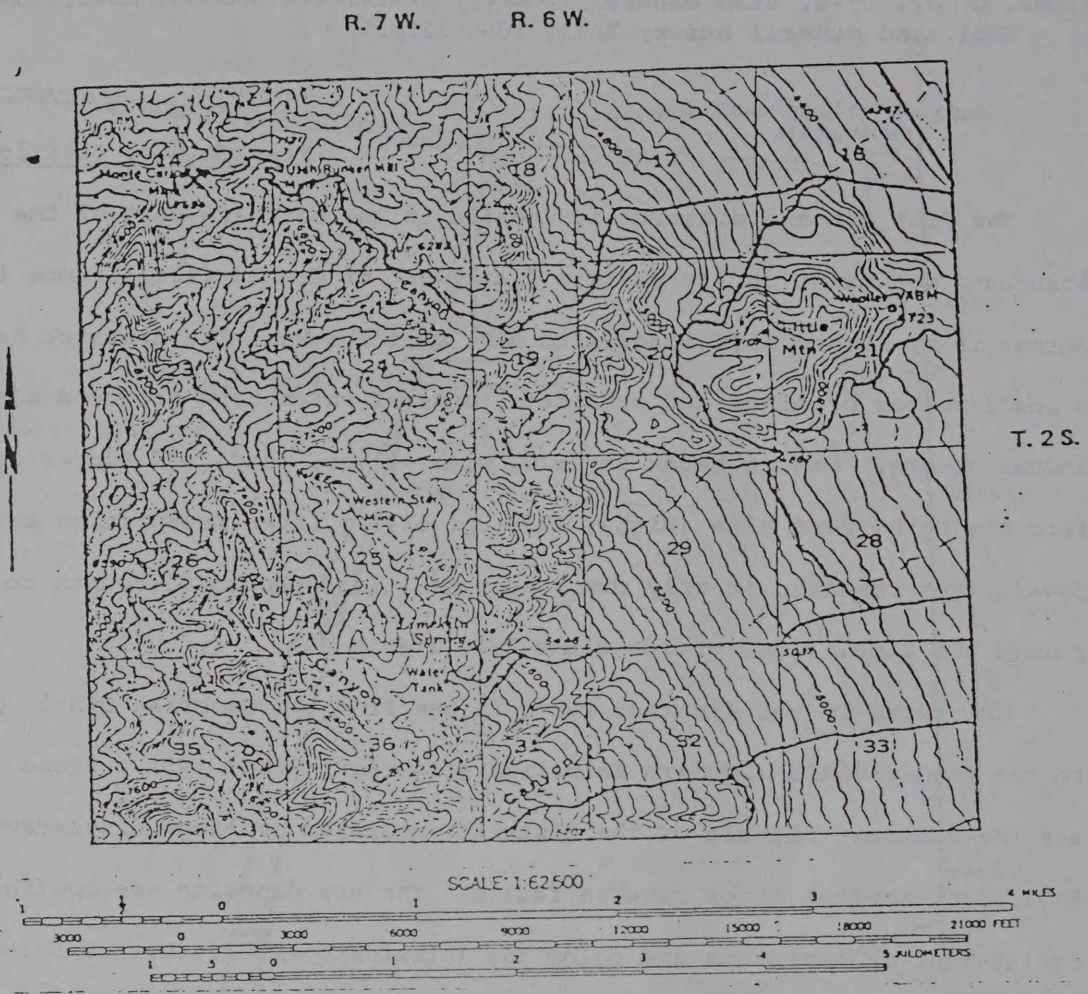
The rocks in the district range in age from the Cambrian Tintic Quartzite to the Pennsylvanian Oquirrh Formation (figures 147 and 148). Broad folds are the dominant feature of the district, modified by large displacement normal faults and several minor reverse faults. The ore deposits are confined to replacement of limestone and dolomites (Mississippian Fitchville Dolomite and Gardison Limestone). Ore deposition is controlled by faults and fissures. The deposits of the district are small, and the ore potential is minor.

Monte Carlo Mine

The Monte Carlo mine is located in SWSWNE 14-2S-7W at an elevation of 7,300 feet (2,225m) and appears to be a small prospect. Historical and production data is not available for this mine. Access is through an adit with minor drifts and crosscuts run from the main level. There are a few raises and winzes where ore was found and stoped. The ore minerals include galena, cerussite, plumbojarosite, and limonite.

The host rock is the Gardner Dolomite (Fitchville) and ore is located in replacement beds striking N. 15° W. and dipping 65° to the west. A reserve of several hundred tons of mineralized rock remains in the mine. A 6-inch (15.2cm)

384



FREE COINAGE DISTRICT

1. Monte Carlo mine

Figure 146: Topographic map of Free Coinage mining district

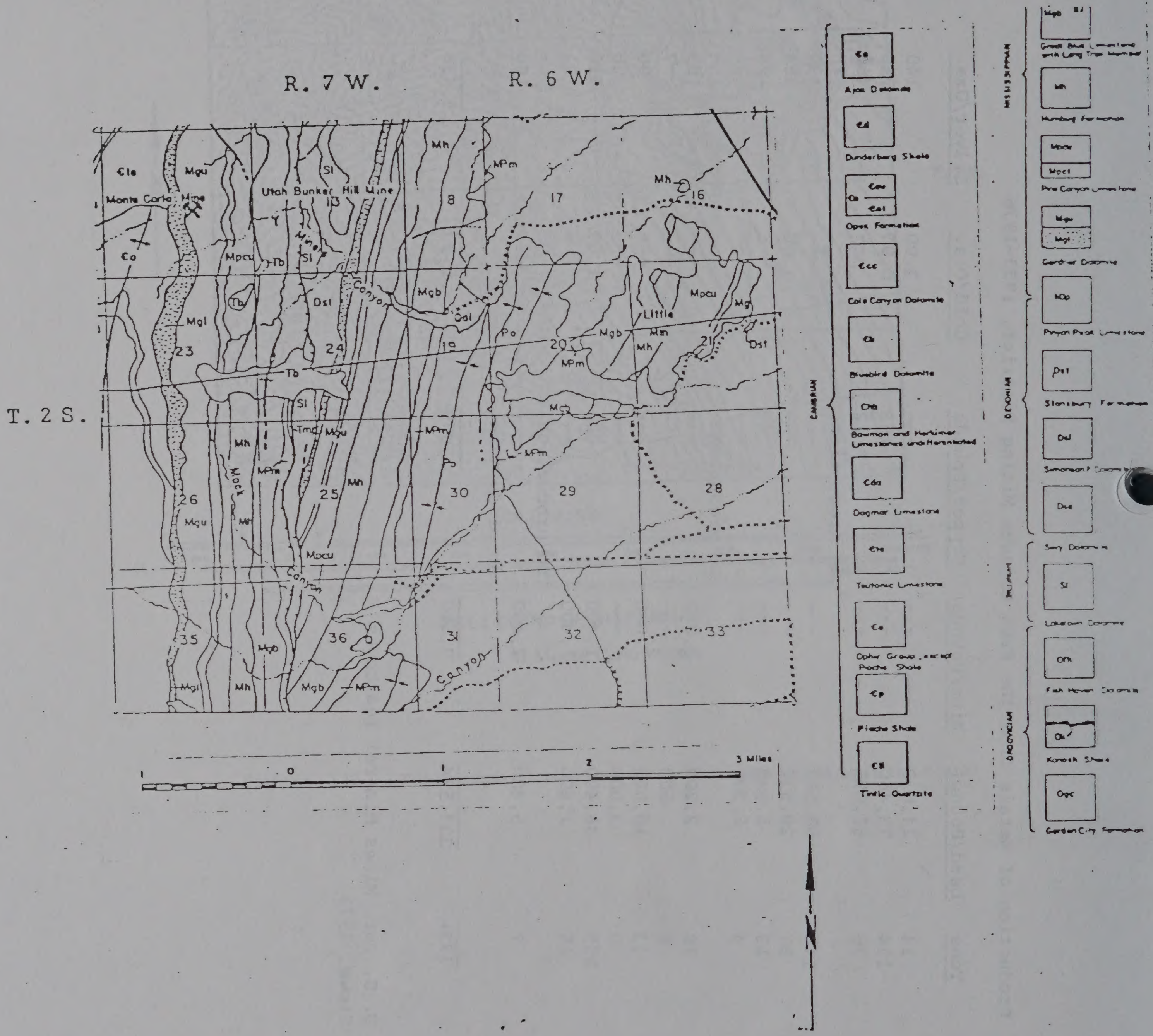
Adapted From: USGS Timpie 15' Quadrangle

Table 39: Production of metals from the Free Coinage Mining District, 1933-1976

Year	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1933	24	24,630	---	---	3.00	140	$963
1934	154	78,460	---	163	0.97	750	3,433
1935	76	52,975	---	12	---	462	2,452
1936-1937				no production			
1938	114	55,587	---	---	---	430	2,835
1939	57	28,532	---	---	1.00	364	1,623
1940	13	5,640	---	44	---	194	425
1941	4	2,300	---	---	---	21	146
1942				no production			
1943	10	2,200	2,000	---	---	59	423
1944	9	600	---	---	---	7	53
1945	33	10,000	600	---	---	90	993
1946	9	3,000	---	---	---	36	356
1947	255	36,400	1,400	860	1.00	716	6,275
1948	15	1,800	1,400	---	---	21	527
1949-1967				no production			
1968	?	5,400	2,100	---	---	160	1,383
1969-1976				no production			
Totals	773+	307,524	7,500	1,079	5.97	3,450	$21,887

Sources: U. S. Bur. Mines Mineral Yearbooks
Stowe, 1975

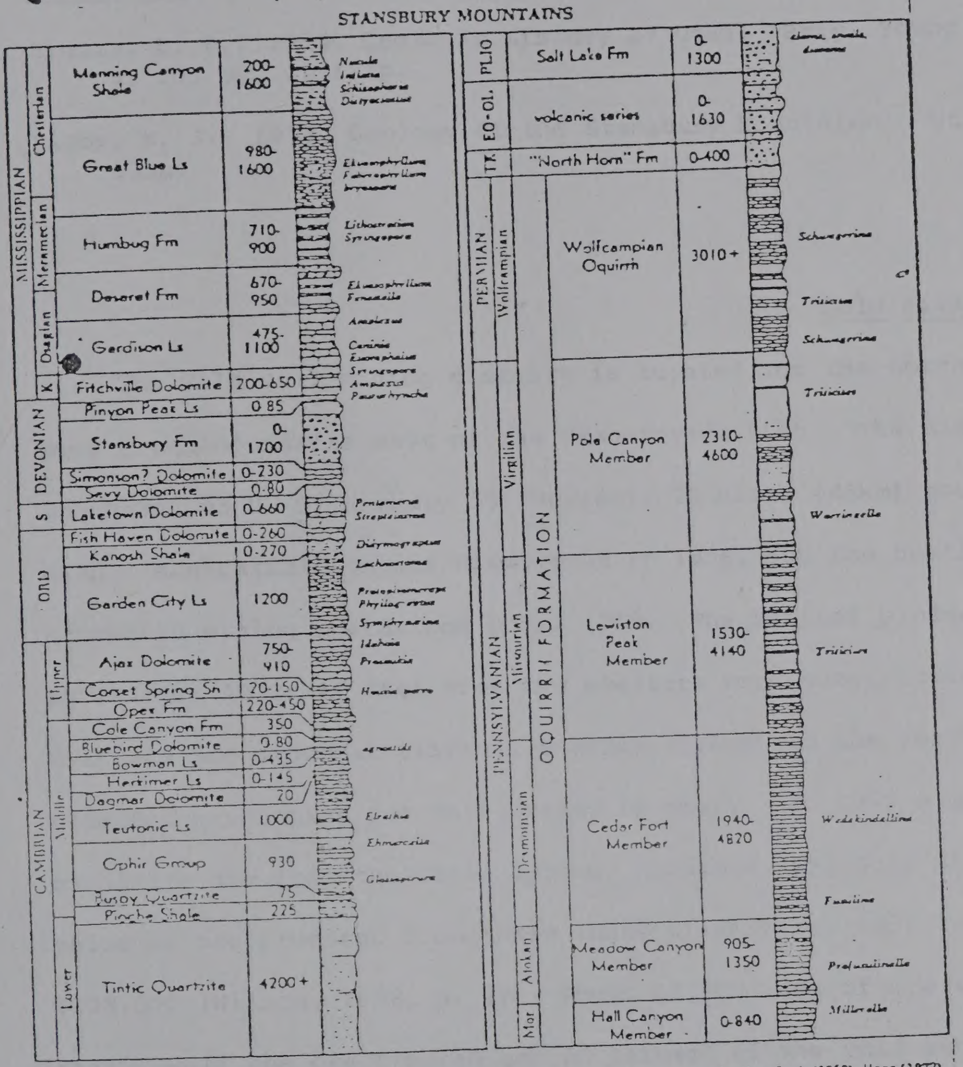
Figure 147:
GEOLOGIC MAP OF THE FREE COINAGE MINING DISTRICT



Adapted from J.K. Rigby, 1958, Geology of the Stansbury Mountains, Eastern Tooele County, Utah, plate 1

Figure 148:

STRATIGRAPHIC COLUMN FOR THE STANBURY MOUNTAINS



After: Rigby (1968); Oquirrh Fm: Wright (1961); Bissell (1962a); Tooker and Roberts (1971); Oligocene volcanics: Davis (1959); Hogg (1972)
Stansbury Island sec: Chapusa (1969); Palmer (1970) Ammonoids from Deseret Limestone: Petersen (1969)

● Ore-bearing horizon

Adapted from L.F. Hintze, Geologic History of Utah, p.128

cut across this mineralization assays 1.84 percent lead, 0.46 percent zinc, 0.006 percent copper, 0.003 ounces gold, and 0.07 ounces silver.

References:

Hintze, L. F., 1973, Geologic history of Utah: Brig. Young Univ. Geol. St., v. 20, pt. 3, 181p.

Rigby, K. J., 1958, Geology of the Stansbury Mountains: Utah Geol. Soc. GB 13, 133p.

Gold Hill (Clifton) District

The Gold Hill mining district is located on the northern end of the Deep Creek Mountains east of the Utah-Nevada line. The district is 28 miles southeast of U. S. Highway 50 (Nevada), 28 miles (45km) southwest of Wendover, Utah. Mineralization was discovered in 1858, but the hostility of Indians prevented mining operations until 1869. The initial production was made either in 1871 or 1872; at that time two smelters were constructed, one at Gold Hill and the other at Clifton, 6 miles (9.6km) to the south, however, the recorded production for this period is small. In 1892 a mill was constructed to handle ore from the Canes Spring, Alvarado, and Gold Hill properties. The value of ore produced from these three properties, 1892 to 1895, totaled $208,000 (Wilson, 1958, p. 1). About 19,000 tons of ore were treated in the mill. Half the ore treated and 60 percent of the gold recovered came from the Alvarado mine. After 1895 activity diminished until 1906. From 1906 to 1917 the Gold Hill property was explored and developed and in 1917 a branch line of the Western Pacific Railroad was completed linking Gold Hill with Wendover and the main line. Large tonnages of ore containing arsenopyrite were discovered in the Gold Hill mine and in the ore bodies of the U. S. mine and considerable amounts of arsenic ore were shipped until 1925 when the arsenic market collapsed. The two mines have been inactive since 1925 except for a short period during World War II (Sept. 1943 to Jan. 1945).

The value of mineral production for the district from 1858 to the present is estimated by Wilson (1958, p. 1) to be $6,800,000. Stowe (1975, p. 44) reports the district has produced 5,471 tons lead, 15 tons zinc, 1,734 tons copper, 25,865 ounces gold, and 832,345 ounces silver valued at $2,878,084. (Table 40) Lead, zinc, gold, silver, copper, tungsten, arsenic and bismuth have been produced along with minor amounts of antimony, vanadium, tin, and molybdenum. The ore bodies of the district can be categorized into pipe-like deposits, veins with silicate minerals in the gangue, veins containing chiefly quartz and metallic sulfides, arsenic replacement bodies, and copper-lead-silver replacement bodies. The Reaper is the only pipe-like deposit containing lead ore. The Frankie, Alvarado, Rube Lead, Rube Gold, and Wilson Consolidated mines have lead or by-product lead in veins with silicate minerals in the gangue. The Boston, Success, Silver Hill, Western Utah Extension Copper Co., Climax, Southern Confederate, Red Jacket, Copper Queen, Midland Mining Co., Cash Boy or Mammoth, Bird and Undine mines have produced lead or zinc ores from veins containing chiefly quartz and metallic sulfides. In the Gold Hill, U. S. and Herat mines lead, or lead as a by-product, has been produced from arsenic replacement bodies. The Monocco, Silver King, Mohawk, Walla Walla, Garrison Monster and Evans mines produced lead and zinc from the copper-lead-silver replacement bodies.

All ore bodies of the Gold Hill mining district are associated with the Gold Hill quartz monzonite stock. Some are found in the stock itself or as skarns in the contact zones. Most of the ore has been produced from the Mississippian Ochre Mountain Limestone and the Gold Hill stock. Some ore is found in the Prospect Mountain Quartzite, Busby Quartzite and Oquirrh Formation. The geology of the district is shown in figures 149 and 150. A location map to the Gold Hill district and its mines is given as figure 151.

Gold Hill Mine

The Gold Hill mine (No. 2) is located in NWSENE 6-8S-17W at an elevation

Table 40: Gold, silver, copper, lead, and zinc produced in the Gold Hill (Clifton) district, 1901-1976.

Year	Mines Prod.	Ore (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)	Value
1901		18		68		666		$ 69
1902		651	482.20	641		6,000		10,554
1903	Not recorded							
1904		1,660	969.00	92				20,085
1905-13	Not recorded							
1914		66	57.25	146	5,054			1,936
1915		16	5.21	149	1,470	1,924		530
1916		67	8.90	645	10,547	4,782		3,532
1917		33,960	564.31	161,204	1,894,731	513,929		705,957
1918		19,714	449.56	97,241	828,658	1,204,472		396,730
1919		14,257	233.89	53,706	194,476	778,869		142,439
1920		39,656	77.43	89,578	92,913	1,010,833		197,204
1921		11,627	266.09	23,208	3,194	336,292		44,253
1922		211	278.61	2,974	4,521	16,524		10,252
1923		13,237	860.60	41,195	33,040	291,554		76,836
1924		33,094	511.05	147,786	3,615	1,840,453		257,290
1925		13,721	808.90	111,372	54,459	1,960,853		272,339
1926		1,382	1,129.20	13,772	13,826	267,083	2,243	55,416
1927		526	926.04	4,413	2,396	53,701	14,754	26,286
1928		195	3.24	1,578	2,995	50,233		4,355
1929		415	480.27	1,229	40,001	1,237		17,703
1930		1,009	77.84	3,704	47,885	280,480		23,284
1931		2,259	1,124.40	2,384	22,046	458,723		43,285
1932		2,882	2,361.00	1,753	9,183	175,333		60,376
1933	10	3,249	2,023.00	10,199	14,714	243,959		39,647

Table 40 continued

Year	Mines Prod.	Ore (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)	Value
1934	15	2,609	458.28	7,747	23,625	297,486		33,922
1935-36	11	2,114	343.20	9,215	30,848	215,391		31,895
1937	8	1,348	235.00	5,382	43,000	78,000		22,193
1938	8	659	207.00	7,210	3,816	89,370		16,391
1939	4	186	128.00	2,092	1,029	17,596		6,834
1940	3	15	1.00	142		9,220		597
1941	1	16	1.00	308	3,100	300		637
1942	1	8	4.00	59		2,400		342
1943	1	1,363		3,292	600	29,800		4,654
1944	1	11,835	241.00	7,349	10,800	43,500		18,599
1945	Not recorded							
1946	2	28		208	1,500	2,000		629
1947	4	518	12.00	1,147	2,700	143,300	6,800	23,483
1948	4	310	10.00	674	800	72,300	5,000	14,741
1949	1	4		42		600	100	145
1950	5	175	31.00	1,696	15,500	11,800		7,437
1951	2	128	3.00	1,022	9,400	8,000		4,689
1952-53	Not recorded							
1954	1	9	1.00	61		1,700		323
1955	4	25	1.00	168	3,200	3,000	200	1,853
1956	8	101	6.00	1,036	4,500	16,800	200	5,726
1957	5	3,938	44.00	2,514	30,200	87,500	362,100	67,421
1958-1976				no production				
Totals:		219,261	15,423.47	820,401	3,464,342	8,667,110	391,397	$2,652,784

Sources: Nolan, 1935, U. S. Bur. Mines Mineral Yearbooks.

PROFESSIONAL PAPER 177 PLATE 1

Figure 149;

GEOLOGIC MAP OF THE GOLD HILL MINING DISTRICT

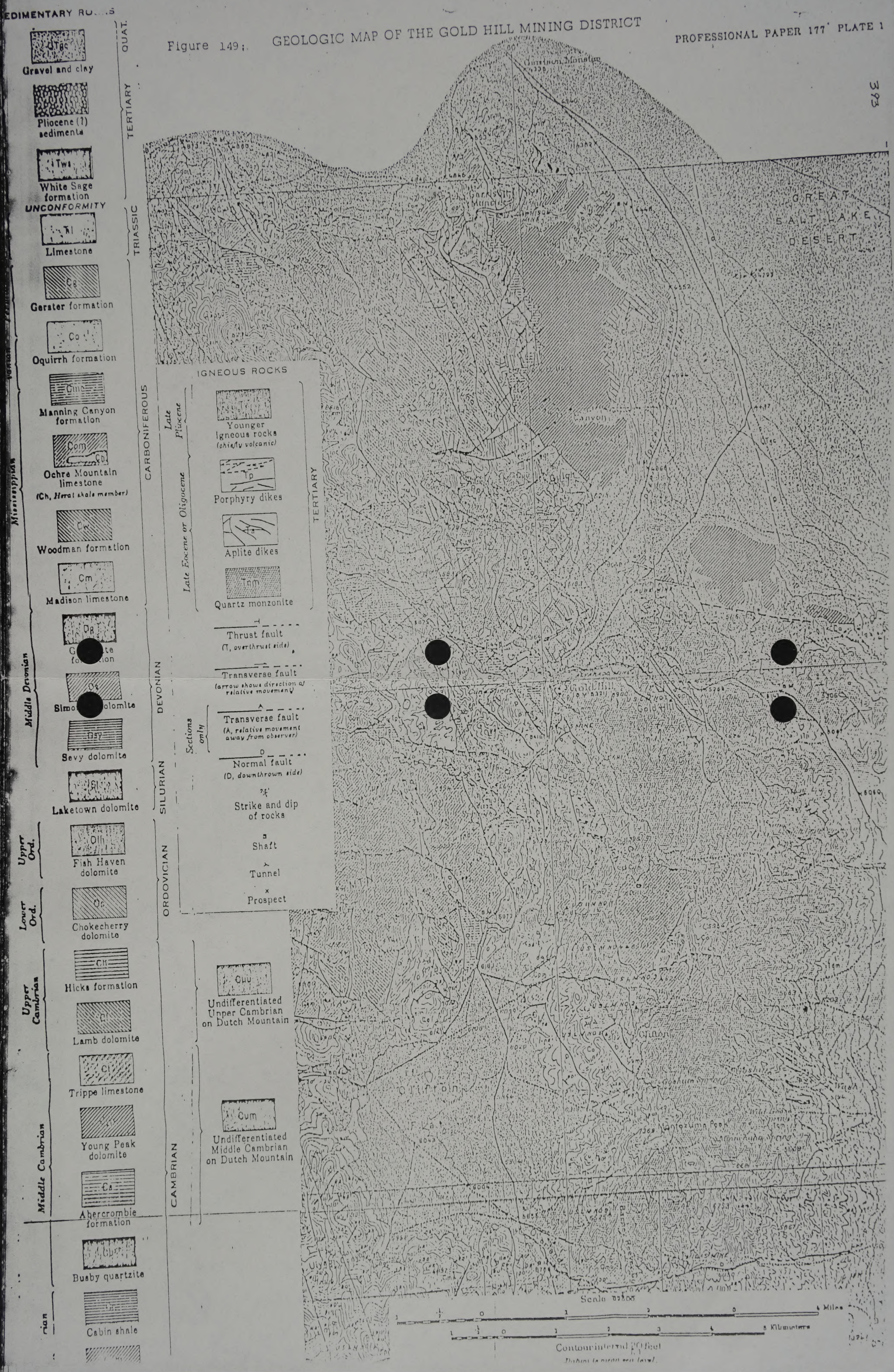


Figure 149; GEOLOGIC MAP OF THE GOLD HILL MINING DISTRICT

PROFESSIONAL PAPER 177 PLATE 1

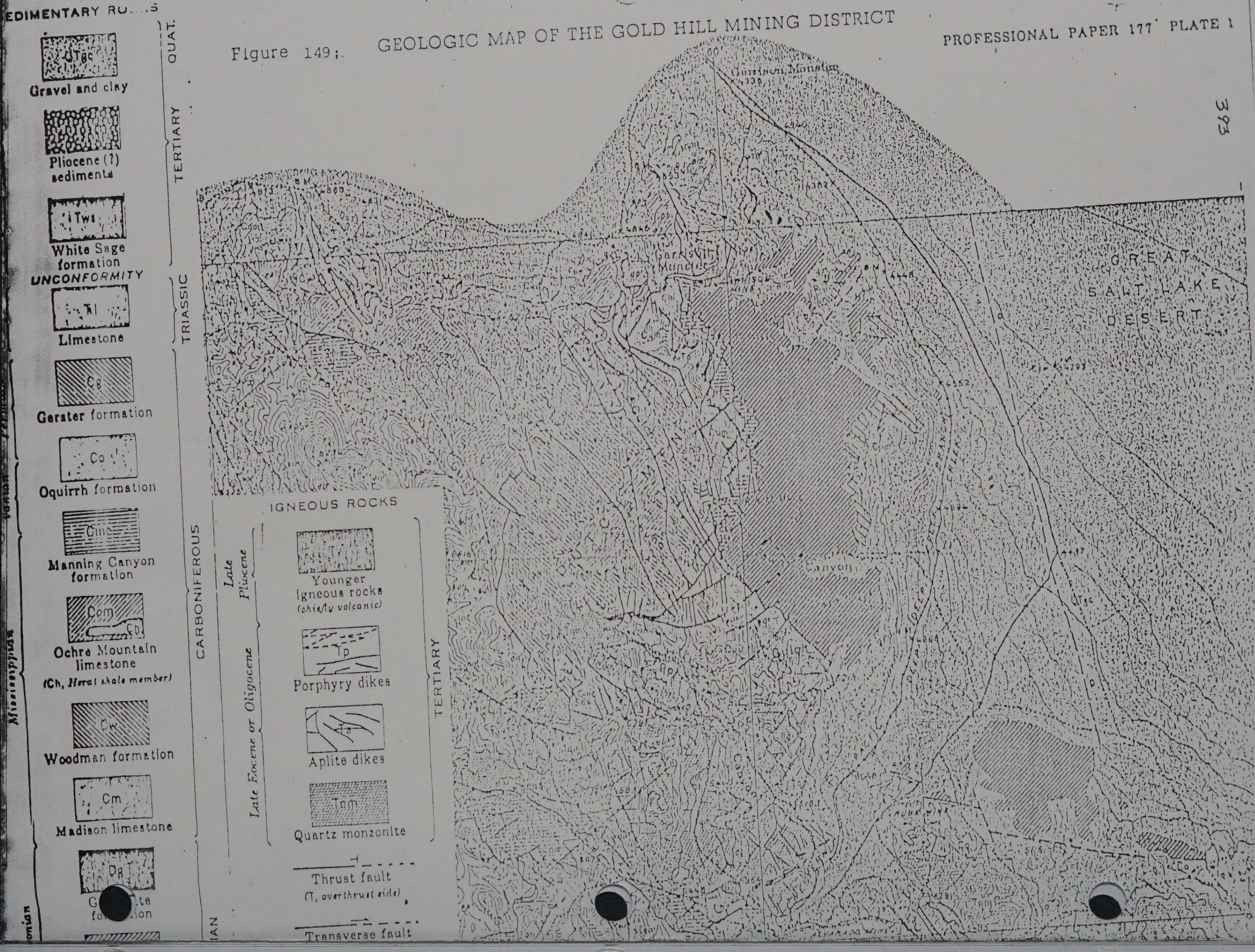
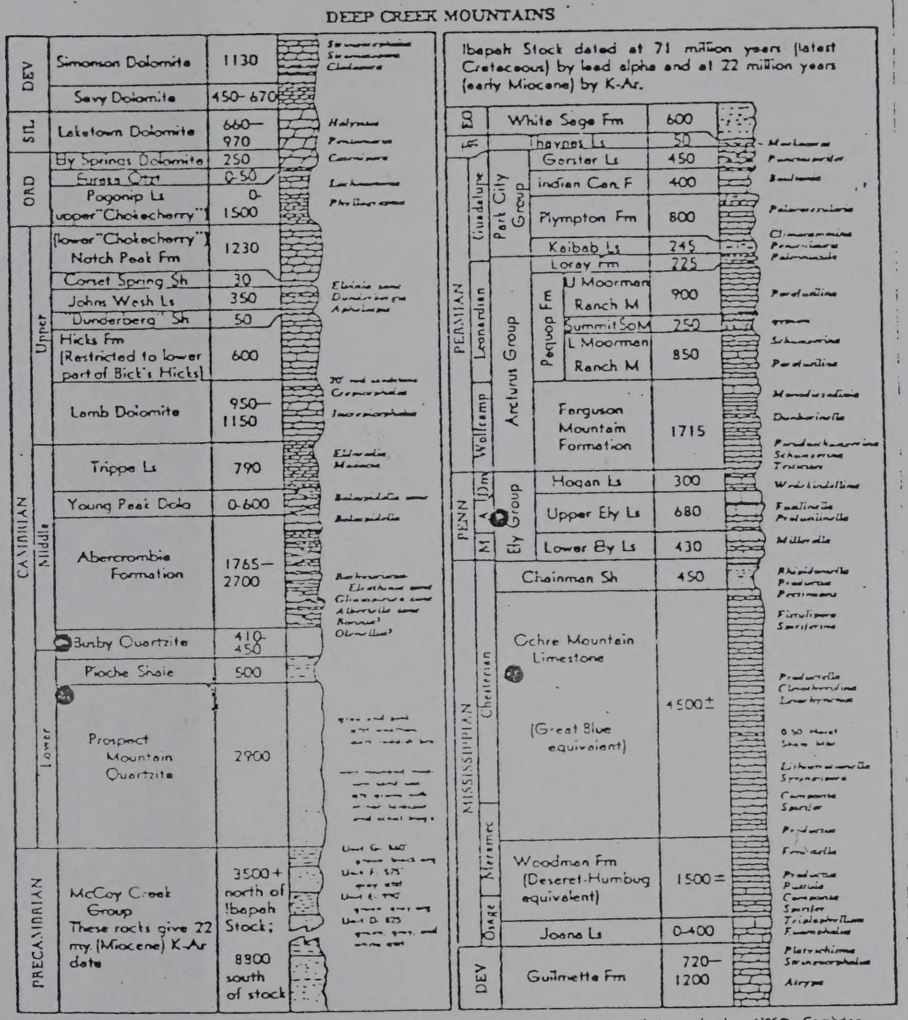


Figure 150: Stratigraphic column for Gold Hill mining district

STRATIGRAPHIC COLUMN OF THE DEEP CREEK MOUNTAINS



After: Bick (1966); Nolan (1935); Pennsylvanian-Permian: Bissell (1962b),(1964a); Devonian: Langenheim and others (1960); Cambrian: Bentley (1958); Robison (1960); Palmer (1960); Precambrian: Misch and Hazzard (1962); Woodward (1965); Ibapah Stock: Armstrong (1970a)

● Ore-bearing horizons

Adapted from Hintze, p. 132

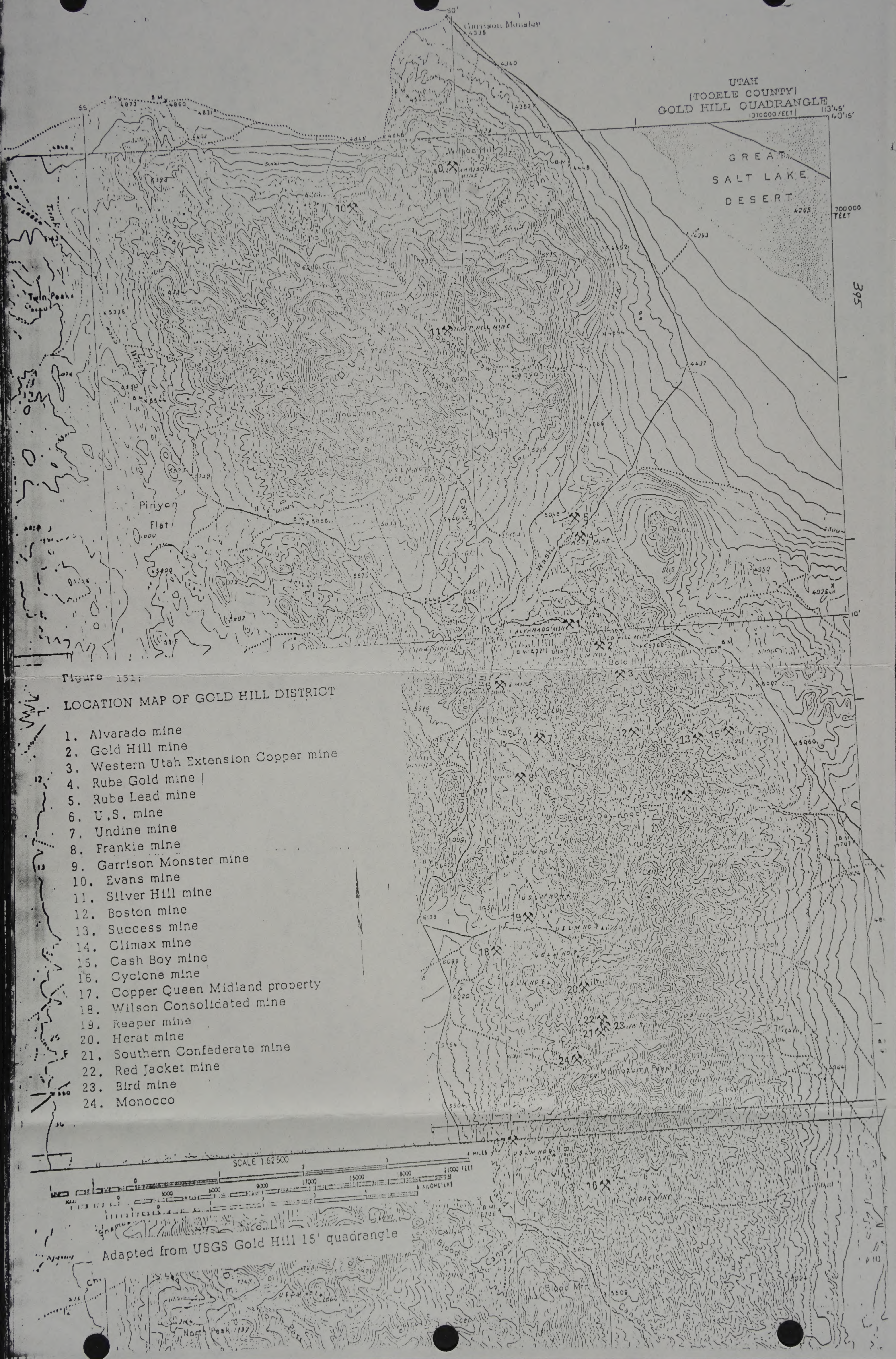


Figure 151:

LOCATION MAP OF GOLD HILL DISTRICT

1. Alvarado mine
2. Gold Hill mine
3. Western Utah Extension Copper mine
4. Rube Gold mine
5. Rube Lead mine
6. U.S. mine
7. Undine mine
8. Frankie mine
9. Garrison Monster mine
10. Evans mine
11. Silver Hill mine
12. Boston mine
13. Success mine
14. Climax mine
15. Cash Boy mine
16. Cyclone mine
17. Copper Queen Midland property
18. Wilson Consolidated mine
19. Reaper mine
20. Herat mine
21. Southern Confederate mine
22. Red Jacket mine
23. Bird mine
24. Monocco

Adapted from USGS Gold Hill 15' quadrangle

of 5,579 feet (1700m) and is the largest mine in the district. Production from the mine, with the exception of a small amount of gold ore produced 1892-1895, began in 1917 with the completion of the Western Pacific Railroad spur from Wendover to Gold Hill. From 1917 to 1929 a total of 171, 637 tons of ore were mined, containing an average assay of 4.66 percent arsenic, 2.07 percent lead, 0.725 percent copper, 4 ounces silver and 0.0075 ounces gold (Wilson, 1958, p. 7). Most of the arsenic ore was mined and shipped 1923 to 1925.

The Ochre Mountain Limestone was the host for the Gold Hill mine ore bodies. The ore in the open pit, near the summit of Gold Hill, is very similar to that found in the Alvarado and Canes Spring mines and consists chiefly of wollastonite, oxidized copper minerals, and native gold. Other ore was derived from coarsely crystalline, white, glassy quartz veins in limestone near its contact with quartz monzonite. The veins contain disseminated tennantite, chalcocite, chrysocolla, malachite, and azurite. Another kind of ore consists primarily of arsenopyrite. Lesser amounts of pyrite, pyrrhotite, sphalerite, galena, and chalcopyrite were found in some parts of the ore bodies, quartz and calcite were the chief gangue minerals. Oxidized parts of ore bodies consisted of scorodite and iron oxides along with a number of zinc, copper, lead, and arsenate minerals. These include adamite, austinite, conichalcite, olivenite, mimetite, and beudantite.

The workings of the Gold Hill mine consist of two shafts, one vertical and one inclined and seven levels; at 80, 150, 300, 400, 600, 700, and 760 feet. The vertical shaft is near the portal of the adit (300-foot level) at an elevation of 5,579 feet (1700m). This shaft is 400 feet (122m) deep and bottoms at the 700-foot level. This level is also cut by the inclined shaft, 700 feet to the south. From the inclined shaft the 400, 600, and 760-foot levels have been driven. There are several adits above the 300-foot level. The glory hole is the most noticeable working seen from the surface and has dimensions of 250 x 75 feet (76 x 23m), most of the upper levels were destroyed

by caving operations in its formation. The estimated length of workings of the Gold Hill mine are 5,200 feet (1585m).

Alvarado Mine

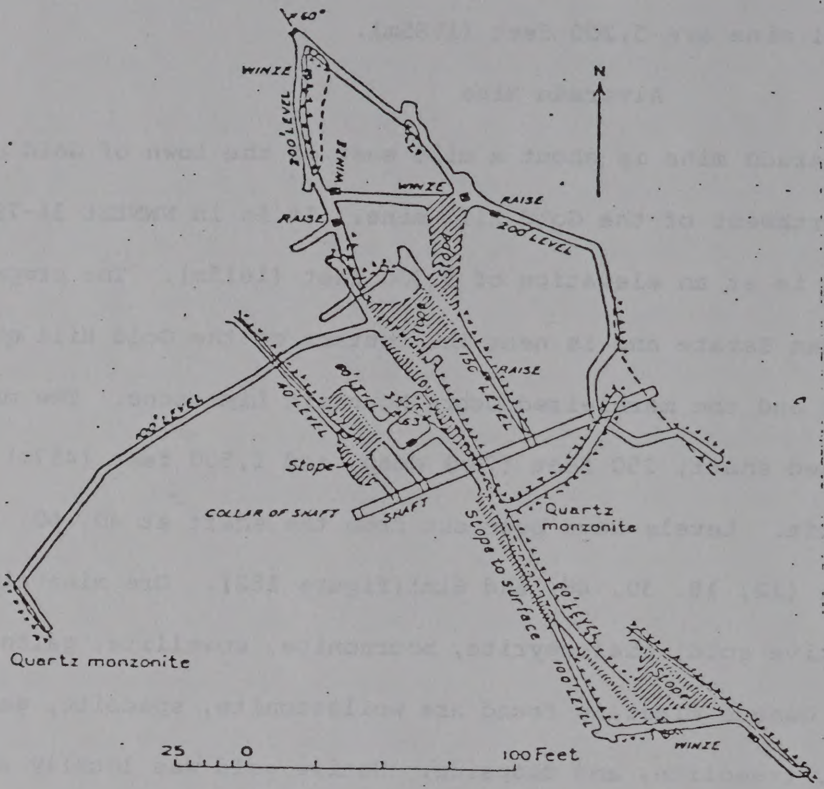
The Alvarado mine is about a mile east of the town of Gold Hill and a half mile northwest of the Gold Hill mine. It is in NWNESE 31-7S-17W and the shaft collar is at an elevation of 5,300 feet (1615m). The property is owned by the Woodman Estate and is near the contact of the Gold Hill quartz monzonite stock and the marbleized Ochre Mountain Limestone. The mine consists of an inclined shaft, 250 feet (76m) deep, and 1,500 feet (457m) of workings from the shaft. Levels have been cut from the shaft at 40, 60, 100, 150, and 200 feet (12, 18, 30, 46, and 61m)(figure 152). Ore minerals found in the mine are native gold, chalcopyrite, bournonite, covellite, galena, and malachite. Gangue minerals found are wollastonite, spadaite, garnet, zoisite, vesuvianite, tremolite, and diopside. Native gold was locally abundant in the mine, where pieces as large as a bean were found. Early ore averaged better than an ounce of gold per ton. Bullion assays indicated a fineness of 0.750 to 0.850, although some was 0.950 fine (Nolan, 1935, p. 131).

Western Utah Extension Copper Co. Mine

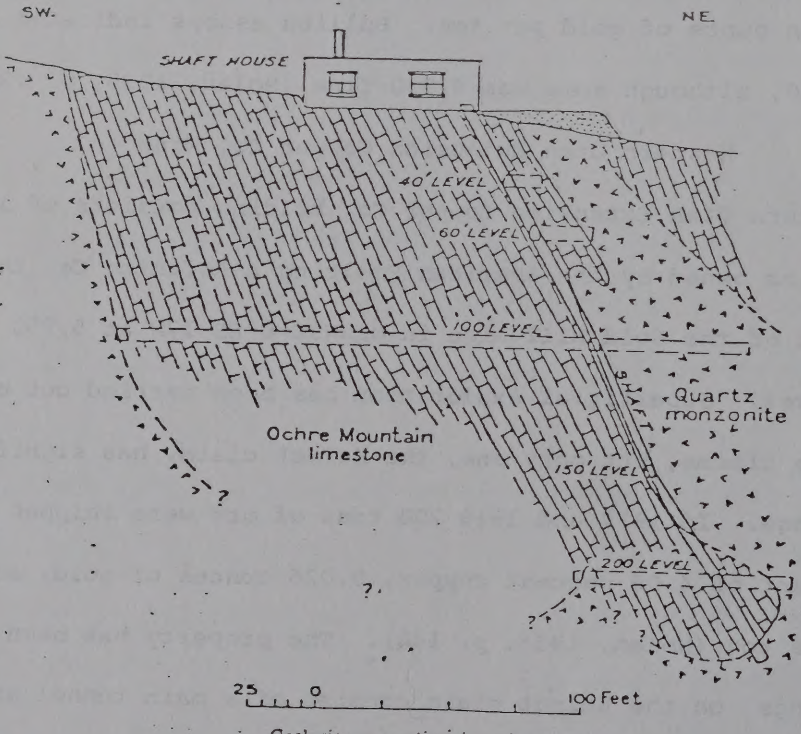
The Western Utah Extension Copper Co. holding consists of a group of 15 patented claims owned by the American Smelting & Refining Co. that lie to the southeast of the Gold Hill mine in NENWSE 6-8S-17W at 5,750 feet (1753m) above sea level. Superficial exploration has been carried out on several places on the claims, but only one, the Helmet claim, has significant underground workings. In 1917 and 1918 200 tons of ore were shipped having an average content of 4.08 percent copper, 0.026 ounces of gold, and 5.4 ounces silver to the ton (Nolan, 1935, p. 146). The property has been idle since 1918. Workings on the Helmet claim consist of a main tunnel and several higher levels. On all of the levels limited stoping has been done, 1,000 feet (305m) of drifting has been done on the tunnel level and two interior shafts

Figure 152:

PLAN AND GEOLOGIC SECTION OF THE ALVARADO MINE



Plan of Alvarado mine workings. Blank areas are limestone.



Geologic cross section through Alvarado shaft.

Adapted from Nolan, 1935, p. 129

have been sunk from it. The portal of the main tunnel is at an elevation of 5,751 feet (1752m) and is more than 250 feet (76m) lower than the summit of the east-west ridge beneath which it is driven (figure 153).

The claim is on the Gold Hill quartz monzonite stock and ore is found in a quartz vein striking approximately north and dipping 60 to 70 degrees west. The ore is almost completely oxidized from the grass roots to the tunnel level and consists of quartz, altered quartz monzonite fragments, and various iron, copper, and arsenic minerals. The vein ranges in thickness from a few inches to 3 feet (0.1-0.9m), in some portions of the mine ore minerals occupy only part of the vein. Sulphide minerals found are arsenopyrite, pyrite, and sphalerite, oxide minerals include copper pitch and scorodite. Locally there are concentrations of blue-green chrysocolla, clinoclasite, and olivenite.

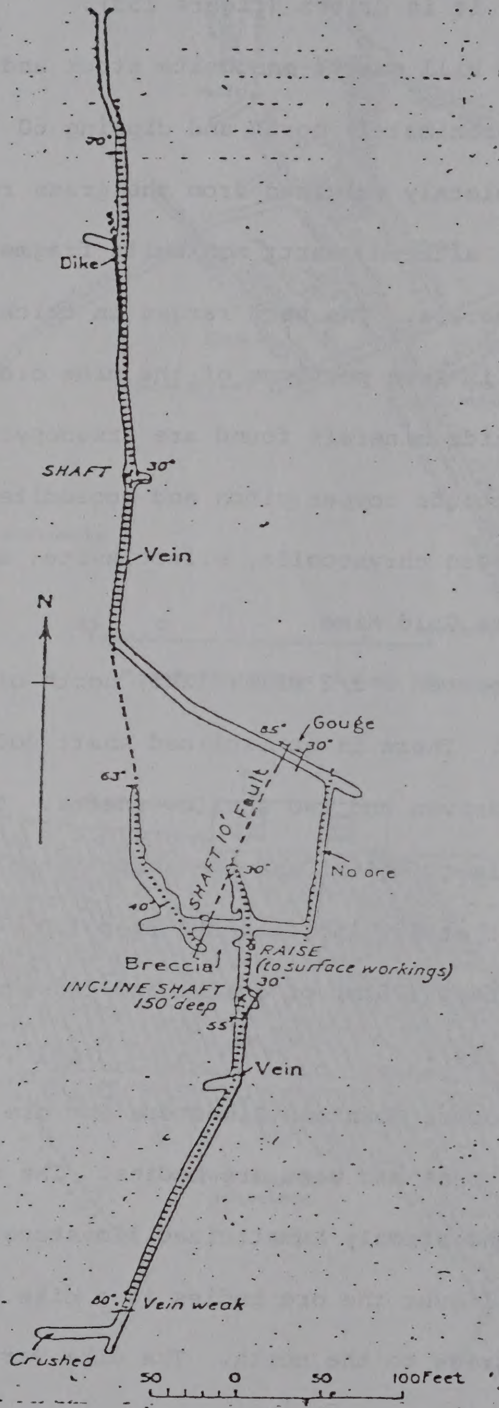
Rube Gold Mine

The Rube Gold mine is located 1 1/2 miles (2km) north of Gold Hill townsite in the SWSWSE 30-7S-17W. There is an inclined shaft 300 feet (91m) deep from which three levels are driven and two shallow shafts. The shaft collar is at an elevation of 4,975 feet (1516m) and the shaft is inclined 65 degrees. Levels are cut from the shaft at 65, 150, and 300 feet (20, 46, and 91m) and in addition there are 2,300 feet (701m) of drifts and crosscuts. The mine is open and accessible (figure 154).

The mine is cut in the Ochre Mountain Limestone and ore was in two tabular ore shoots designated as the east and west ore bodies. The ore shoots are thickly bedded, heavily fractured, and strongly hematitized limestone, locally heavily silicified. The hanging wall over the ore bodies is a dike with a nearly east-west strike that dips 60 degrees to the north. The dike varies in thickness from a few inches to 3 feet (15cm-0.9m). Three types of ore have been shipped from the mine. The most common is an oxide lead ore consisting of anglesite and cerussite containing native gold in a fine-grained, silicified hematitized limestone. This ore grades into a less oxidized ore of galena and minor pyrite.

Figure 153:

Plan map of the tunnel level of Western Utah Extension Copper Company

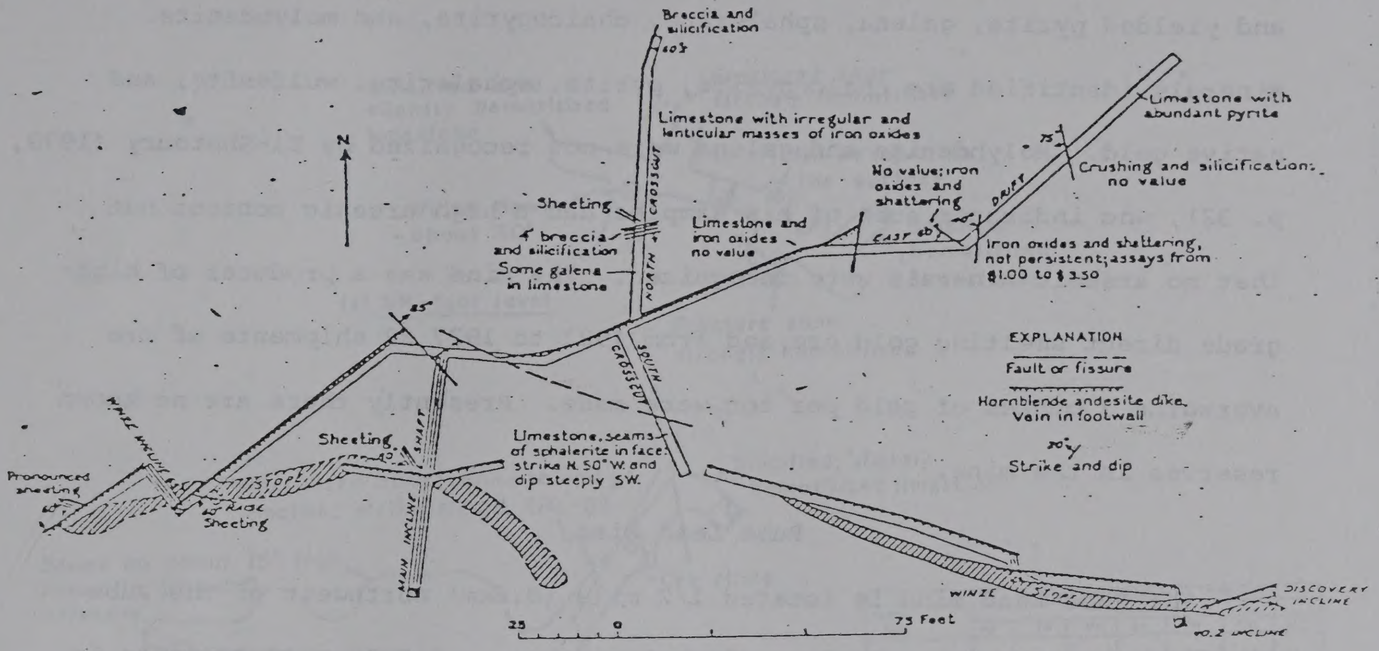


Adapted from Nolan, 1935, p. 146

401

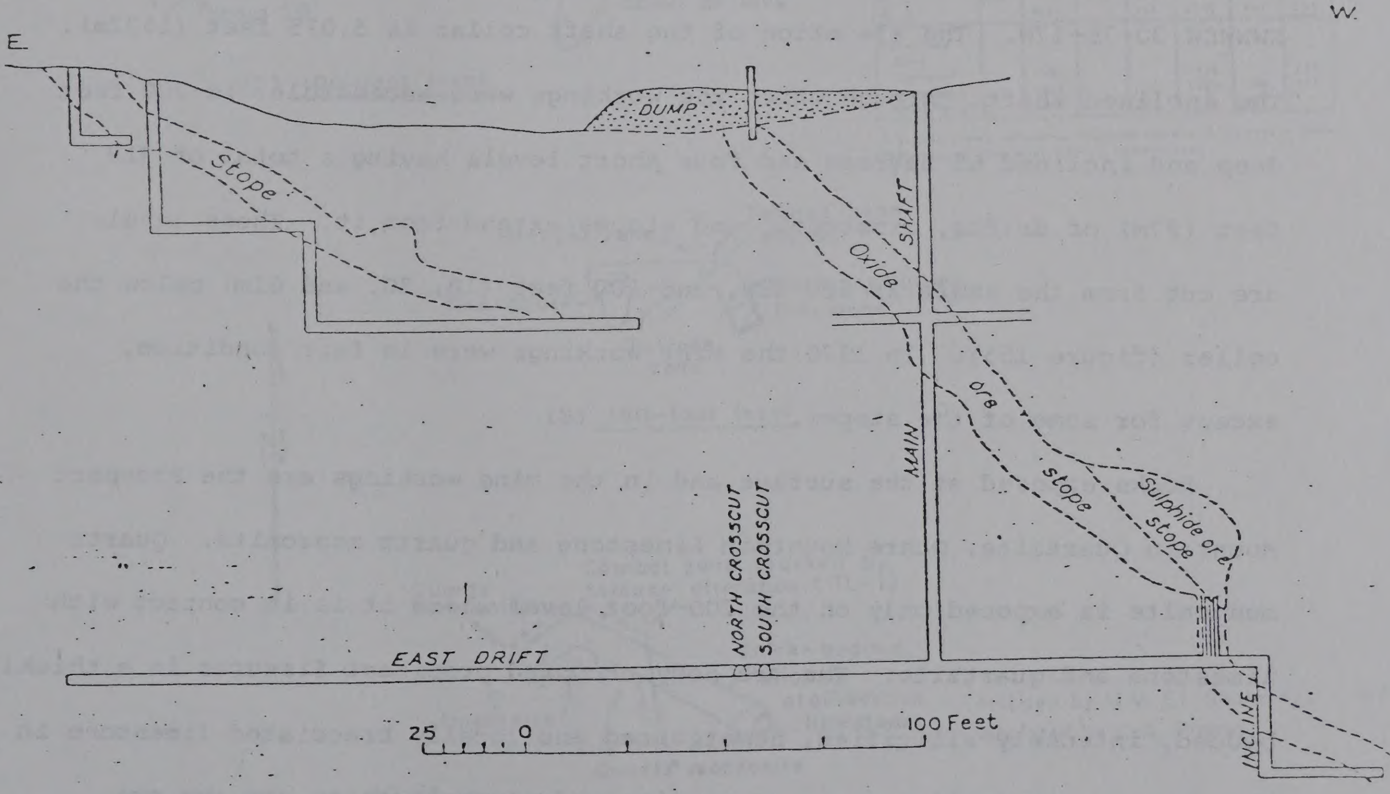
Figure 154:

PLAN AND SECTION OF THE RUBE GOLD MINE



Breccia and silicification
60°
Limestone with irregular and lenticular masses of iron oxides
N
NORTH CROSSCUT
Sheeting
breccia and silicification
Some galena in limestone
Limestone and iron oxides no value
No value; iron oxides and shattering
75°
EAST DRIFT
Limestone with abundant pyrite
Crushing and silicification; no value
Iron oxides and shattering, not persistent; assays from $1.00 to $3.50
EXPLANATION
Fault or fissure
Hornblende andesite dike. Vein in footwall
Strike and dip
45°
SOUTH CROSSCUT
Sheeting
Limestone, seams of sphalerite in face; strike N. 50° W. and dip steeply SW.
MAIN INCLINE SHAFT
WINZE
STOPE
Pronounced sheeting
60°
Sheeting
WINZE
STOPE
DISCOVERY INCLINE
NO. 2 INCLINE
25 0 75 Feet

Plan of mine workings, Rube mine. From map furnished by Leffler Palmer.



Longitudinal section through Rube mine. Furnished by Leffler Palmer.

Adapted from Nolan, 1935, p. 137

Native gold is enclosed in galena and embayed in a bluish-gray fine-grained limestone. Sulphide ore was stoped in the west end of the 150-foot level and yielded pyrite, galena, sphalerite, chalcopyrite, and molybdenite. Minerals identified are chalcopyrite, pyrite, sphalerite, wulfenite, and native gold. Molybdenite and galena were not recognized by El-Shatoury (1970, p. 32), who indicates some of his samples had a high arsenic content but that no arsenic minerals were recognized. The mine was a producer of high-grade direct smelting gold ore and from 1921 to 1927 22 shipments of ore averaging 7 ounces of gold per ton were made. Presently there are no known reserves in the mine.

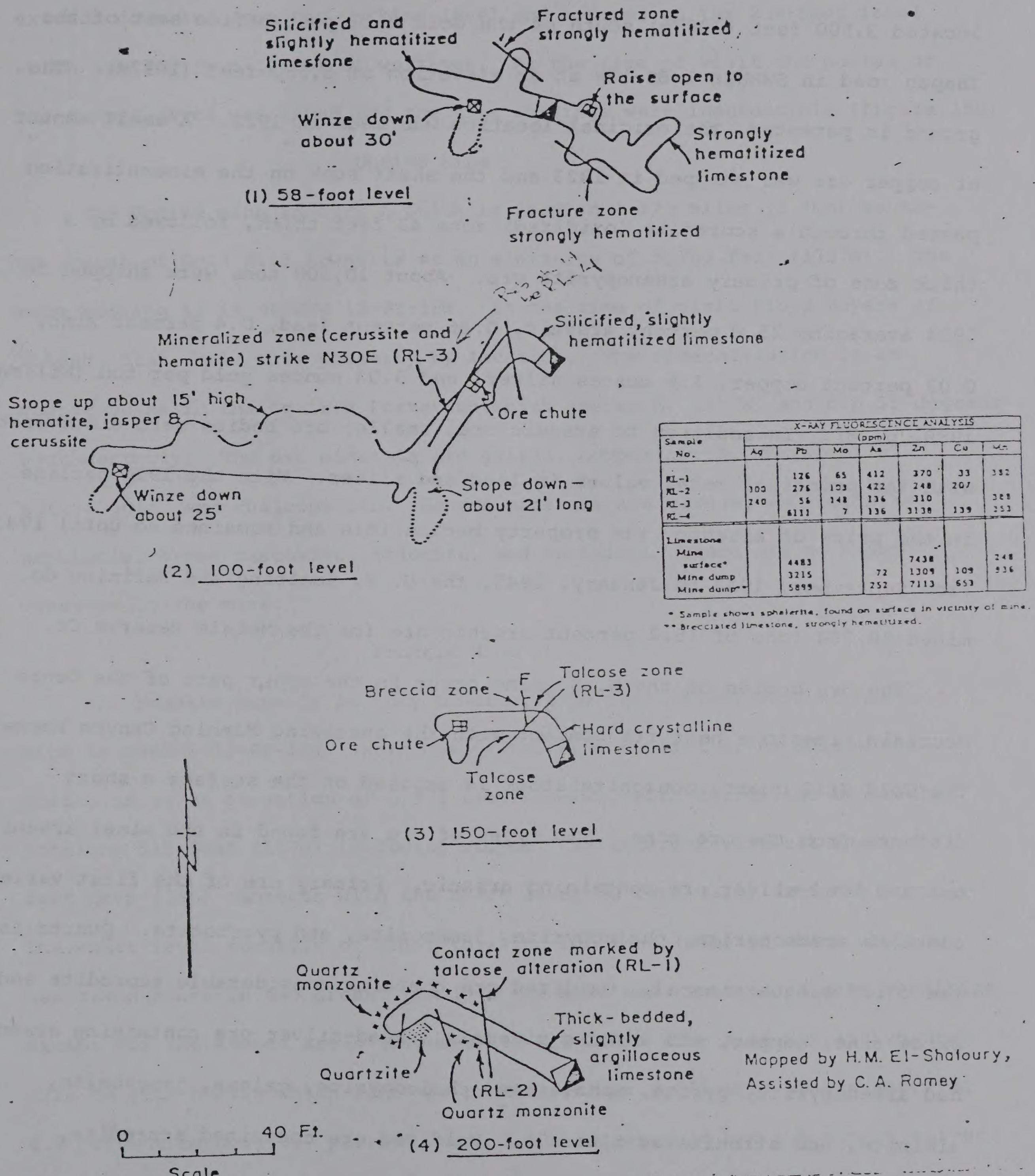
Rube Lead Mine

The Rube Lead mine is located 1/2 mile (0.8km) northwest of the Rube Gold mine and about 1 1/2 miles (2.4km) northeast of Gold Hill townsite in SWNWSW 30-7S-17W. The elevation of the shaft collar is 5.025 feet (1532m). The inclined shaft, through which the workings were accessible, is 200 feet deep and inclined 65 degrees and four short levels having a total of 318 feet (97m) of drifts, crosscuts, and stopes extend from it. These levels are cut from the shaft at 58, 150, and 200 feet (18, 30, and 61m) below the collar (figure 155). In 1970 the mine workings were in fair condition, except for some of the stopes.

Rocks exposed at the surface and in the mine workings are the Prospect Mountain Quartzite, Ochre Mountain Limestone and quartz monzonite. Quartz monzonite is exposed only on the 200-foot level where it is in contact with limestone and quartzite. The ore body occupied prominent fissures in a thickly bedded, intensely silicified, hematitized and locally brecciated limestone in the Ochre Mountain Limestone. Cerussite and plumbojarosite are the ore minerals, early reports claim that a few pockets with nodules of galena were seen during development work. Small shipments of lead carbonate ore carrying small amounts of silver are believed to have been made from the mine. There

Figure 155:

PLAN OF THE WORKINGS OF THE RUBE LEAD MINE


Silicified and slightly hematitized limestone
Fractured zone strongly hematitized
Raise open to the surface
Winze down about 30'
Strongly hematitized limestone
(1) 58-foot level
Fracture zone strongly hematitized
Mineralized zone (cerussite and hematite) strike N30E (RL-3)
Silicified, slightly hematitized limestone
Stope up about 15' high hematite, jasper & cerussite
Ore chute
Winze down about 25'
Stope down — about 21' long
(2) 100-foot level
Breccia zone
F
Talcose zone (RL-3)
Hard crystalline limestone
Ore chute
Talcose zone
(3) 150-foot level
N
Quartz monzonite
Contact zone marked by talcose alteration (RL-1)
Thick-bedded, slightly argillaceous limestone
Quartzite
(RL-2)
Quartz monzonite
(4) 200-foot level
0
40 Ft.
Scale

X-RAY FLUORESCENCE ANALYSIS

Sample No.	Ag (ppm)	Pb	Mo	As	Zn	Cu	Mn
RL-1		126	65	412	370	33	332
RL-2	300	276	103	422	248	207	
RL-3	240	56	148	136	310		328
RL-4		6111	7	136	3138	139	353
Limestone							
Mine surface*		4483			7438		248
Mine dump		3215		72	1309	109	936
Mine dump**		5899		252	7113	653	

* Sample shows sphalerite, found on surface in vicinity of mine.
** Brecciated limestone, strongly hematitized.

Mapped by H.M. El-Shatoury,
Assisted by C.A. Ramey

Adapted from El-Shatoury, 1970, 35

are no known reserves and no production figures available for the mine.

U. S. Mine

The U. S. mine is owned by U. V. Industries of Salt Lake City and is located 3,500 feet (1067m) south of the Gold Hill post office east of the Ibapah road in SWNWSE 1-8S-18W at an elevation of 5,550 feet (1692m). The ground is patented, the original location was made in 1922. A small amount of copper ore was shipped in 1923 and the shaft sunk on the mineralization passed through a scorodite (oxidized) zone 42 feet thick, followed by a thick zone of primary arsenopyrite ore. About 10,000 tons were shipped in 1924 averaging 25.8 percent arsenic, 0.86 percent lead, 0.4 percent zinc, 0.02 percent copper, 1.6 ounces silver, and 0.03 ounces gold per ton (Wilson, 1958, p. 8). In addition to arsenic ore, smaller ore bodies were discovered with the principal metal values in lead and silver. With the 1926 decline in the price of arsenic the property became idle and remained so until 1943. From September, 1943 to January, 1945, the U. S. Smelting and Refining Co. mined 98,784 tons of 15.2 percent arsenic ore for the Metals Reserve Co.

The ore bodies of the U. S. mine occur in the upper part of the Ochre Mountain Limestone near its contact with the overlying Manning Canyon Formation. The Gold Hill quartz monzonite stock is exposed on the surface a short distance from the ore zone. Two types of ore are found in the mine; arsenic ore and lead-silver ore containing arsenic. Primary ore of the first variety contains arsenopyrite, chalcopyrite, jamesonite, and pyrrhotite. Quartz is the chief gangue mineral. Oxidized ore contains considerable scorodite and oxide zinc, copper, and arsenic minerals. Lead-silver ore containing arsenic had arsenopyrite, pyrite, sphalerite, chalcopyrite, galena, jamesonite, aikinite, and stibnite as minerals. Oxidized ore contained scorodite, cerussite and jarosite. The principal working of the mine is a crosscut tunnel to the ore body and is the chief means of access. It connects with 800 feet (244m) of drifts and crosscuts that make up the tunnel level. The working level is another series of workings 20 feet (6m) above the tunnel level and a vertical shaft extends from this level to the surface. An inclined shaft extends downward from the working level and bottoms on the 234-foot level which has 700 feet (213m) of workings. At the time of visit the portal of the tunnel level was caved and the mine workings were inaccessible (figure 156).

Undine Mine

The Undine mine in Lucy L Gulch is located 1 1/3 miles (2.1km) south-southeast of Gold Hill townsite at an elevation of 5,700 feet (1737m). The main working is in NESWNW 12-8S-18W. At the time of visit Floyd Meyers of Ibapah, Utah, held this property by location. The mineralization is in quartz veins in the Oquirrh Formation which strike N. 15° W. and dip 55 degrees southwesterly. The ore minerals are galena, copper pitch, chrysocolla, native gold, and chalcopyrite. Gangue minerals are garnet, wollastonite, amphibole, green muscovite, chlorite, and sericite. There are no known reserves in the mine.

Frankie Mine

The Frankie mine is in Lucy L Gulch, 2000 feet (610m) west of the Lucy L mine in SWSENW 12-8S-18W. Workings of the mine consist of an adit whose portal is at an elevation of 5,972 feet (1820m), with drifts and crosscuts totaling 515 feet (157m) including stopes. An interior vertical shaft 47 feet deep (14m) connects with the shaft level 68 feet (21m) from the portal. The shaft level consists of drift totaling 155 feet (47m) on which stoping has taken place in two areas. In 1970 the mine was reported in good condition except for the stoped areas (figures 157 and 158). The mine was active from 1916 to 1919 during which time the production was 3,056 tons of ore assaying 4.8 percent copper, 9.7 percent lead, 0.008 ounces gold and 1.5 ounces silver.

The ore is in the Ochre Mountain Limestone which strikes N. 3° W. and dips 65 degrees east. The ore occurs at the contact of the Gold Hill stock and the Ochre Mountain Limestone. The ore minerals of the Frankie mine are bornite

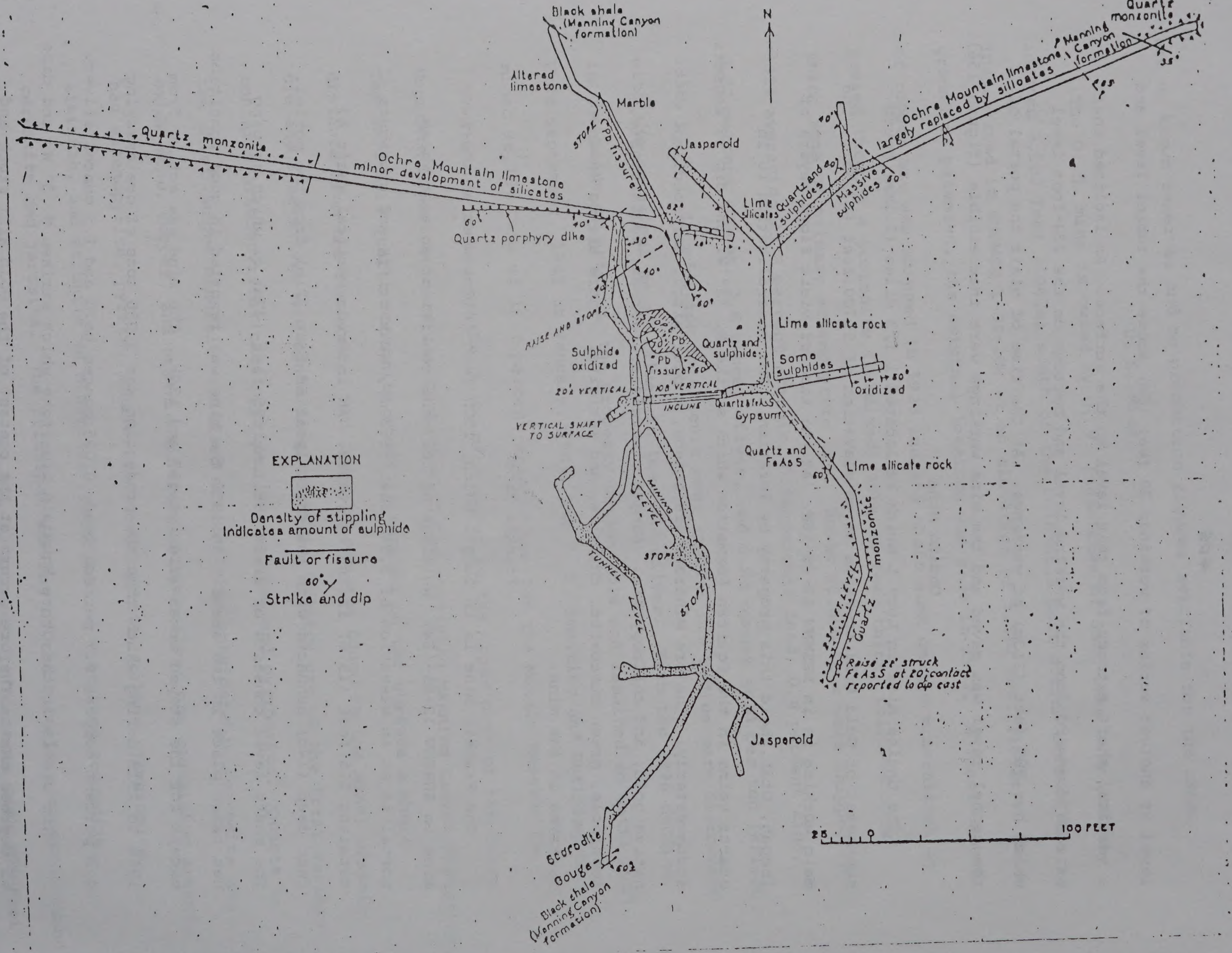
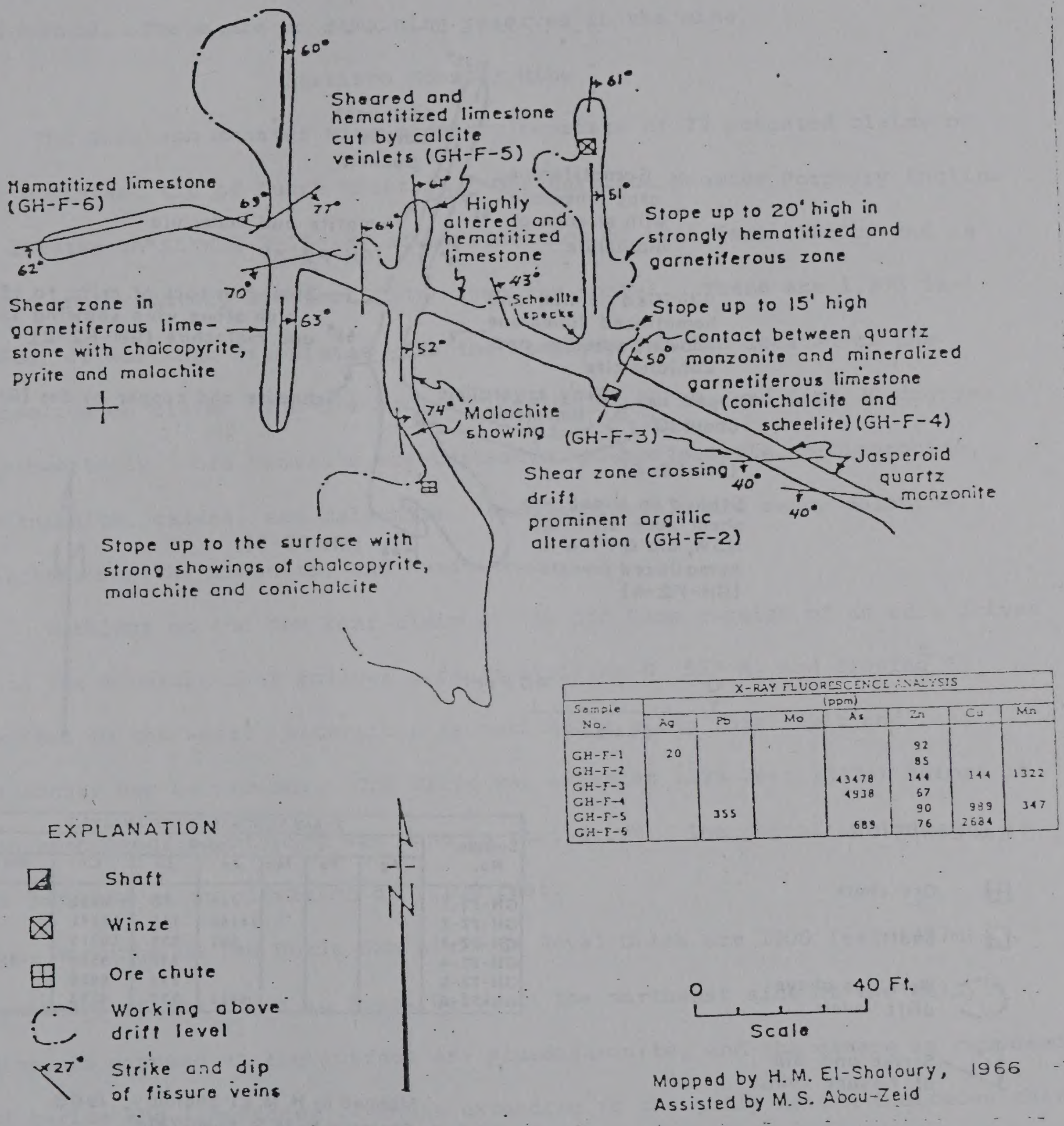


Figure 156: Workings of the U.S. mine

[A]dapted from Nolan, 1935, p. 157

Figure 157:

PLAN OF THE WORKINGS OF THE ADIT LEVEL OF THE FRANKIE MINE


60°
Sheared and hematitized limestone cut by calcite veinlets (GH-F-5)
61°
Hematitized limestone (GH-F-6)
69°
77°
61°
Highly altered and hematitized limestone
51°
Stope up to 20' high in strongly hematitized and garnetiferous zone
64°
62°
70°
43°
Scheelite specks
Shear zone in garnetiferous limestone with chalcopyrite, pyrite and malachite
63°
Stope up to 15' high
52°
Contact between quartz monzonite and mineralized garnetiferous limestone (conichalcite and scheelite) (GH-F-4)
50°
74°
Malachite showing
(GH-F-3)
Jasperoid
quartz monzonite
Shear zone crossing drift prominent argillic alteration (GH-F-2)
40°
40°
Stope up to the surface with strong showings of chalcopyrite, malachite and conichalcite
EXPLANATION
Shaft
Winze
Ore chute
Working above drift level
27°
Strike and dip of fissure veins
N
0
40 Ft.
Scale

X-RAY FLUORESCENCE ANALYSIS

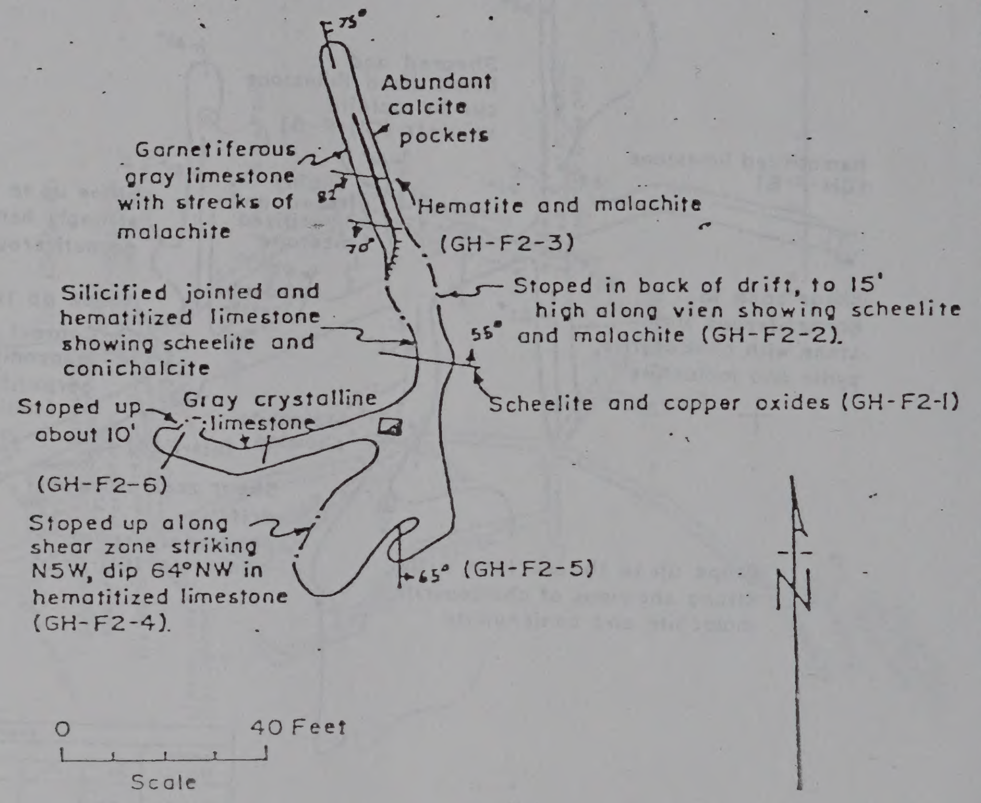
Sample No.	Ag (ppm)	Pb	Mo	As	Zn	Cu	Mn
GH-F-1	20				92		
GH-F-2					85		
GH-F-3				43478	144	144	1322
GH-F-4				4938	67		
GH-F-5		355			90	989	347
GH-F-6				685	76	2684	

Mapped by H. M. El-Shatoury, 1966
Assisted by M. S. Abou-Zeid

Adapted from El-Shatoury, 1970, p. 26

Figure 158:

PLAN OF THE WORKINGS OF THE SHAFT LEVEL OF THE FRANKIE MINE


75°
Abundant calcite pockets
Garnetiferous gray limestone with streaks of malachite
82°
70°
Hematite and malachite (GH-F2-3)
Stoped in back of drift, to 15' high along vien showing scheelite and malachite (GH-F2-2).
55°
Silicified jointed and hematitized limestone showing scheelite and conichalcite
Scheelite and copper oxides (GH-F2-1)
Stoped up about 10'
Gray crystalline limestone
(GH-F2-6)
Stoped up along shear zone striking N5W, dip 64°NW in hematitized limestone (GH-F2-4).
65° (GH-F2-5)
N
0
40 Feet
Scale

EXPLANATION

⊞ Ore chute

Shaft

Workings above drift levels

26° Strike and dip of fissure veins

Sample No.	X-RAY FLUORESCENCE ANALYSIS (ppm)						
	Ag	Pb	Mo	As	Zn	Cu	Mn
GH-F2-1				443	70	3951	
GH-F2-2				14160	111	16441	
GH-F2-3				581	235	16219	
GH-F2-4					430	9563	1485
GH-F2-5					238	8906	
GH-F2-6				6815	132	4193	

Mapped by H. M. El-Shatoury, 1966
Assisted by M. S. Abou-Zeid

Adapted from El-Shatoury, 1970, p. 27

and chalcopyrite with their oxidation products; copper pitch, conichalcite, chrysocolla, and malachite. Some galena and its alteration products, cerussite and anglesite, are also present along with scheelite. Gangue minerals are tourmaline, garnet, diopside, amphibole, apatite, quartz, calcite, pyrite, and humite. There are no remaining reserves in the mine.

Garrison Monster Mine

The Garrison Monster mine property consists of 27 patented claims on the northeast tip of Dutch Mountain. The Garrison Monster Porphyry incline is located in SENWSE 2-7S-18W at an elevation of 5412 feet (1650m) and is caved approximately 100 feet (30m) from the portal. There are 1,200 feet (366m) of workings associated with the Porphyry incline located on the Consolidated claim. The ore body strikes N. 30-60° E. and dips 30 degrees northwesterly. Ore minerals are cerussite, plumbojarosite, hemimorphite, smithsonite, galena, and malachite. Gangue minerals are sandy dolomite, calcite, barite, limonite, and hematite.

Workings on the New Year claim at the Old Camp consist of an adit driven into the mountain that follows a fault striking N. 55° E. and dipping 65 degrees to the west. Alteration is noticeable along this fault and lead carbonate may be present. The drift was extended 1125 feet (343m) before it was abandoned; no stoping was done in this drift. The portal of the adit is in 2-7S-18W at an elevation of 5,100 feet.

Workings on the Uncle Sam claim in Royal Gulch are 1500 feet (457m) southeast of the cabin in Royal Gulch on the northeast side of the gully. Minerals exposed at the surface are plumbojarosite, and the gangue is composed of barite and limestone. A chute extending to the gully bottom indicates that some shipments of ore may have been made from this claim. Another working of the Garrison Monster mine property, probably developed after 1935, is located in NE 2-7S-18W at an elevation of 5,000 feet (1524m). The portal of an adit is caved and the dump suggests several hundred feet of workings. High-grade lead-zinc carbonate ore remains on the dump as well as limonite and hematite.

Evans Mine

The Evans mine property consists of 21 patented claims belonging to a Mr. Johnson of Salt Lake City and covers a large part of Royal Gulch adjacent to the Garrison Monster property at the north end of Dutch Mountain. Workings consist of shallow pits, shafts, and tunnels located at various places on the property. The Evans mine is located 1/4 mile (0.4km) from the mouth of Royal Gulch in NENWSE 10-7S-18W at an elevation of 5,593 feet (1705m). It consists of an adit driven into the northeast side of Royal Gulch which has 700 feet (213m) of drifts and crosscuts. Two winzes were sunk below the adit level and are 60 feet (18m) deep each. Ore is in highly fractured Madison Limestone and is of two varieties: galena-barite replacement deposits and quartz-tetrahedrite veins. The galena-barite ore bodies are oxidized to cerussite-plumbojarosite and only residual galena is present. A small amount of lead ore remains in the mine.

Spotted Fawn (Silver Hill) Mine

This mine is located in Spotted Fawn Canyon on the east side of Dutch Mountain in SENWNE 14-7S-18W at an elevation of 6,450 feet (1966m). Shipments of 78 tons were made from the property during the years 1901 to 1917 averaging 18.1 percent lead, 0.38 ounces gold and 25.1 ounces silver to the ton. Workings are on both the north and south sides of the canyon. On the north side are two shallow shafts and an adit with 225 feet (69m) of drifts and crosscuts. It is cut in Middle Cambrian Busby Quartzite and mineralization consists of a little limonite, possibly some oxide lead ore. An adit is on the south side of the canyon which intersects an ore body striking N. 15° E. and dipping 50-65 degrees to the west. Ore minerals are anglesite, cerussite and galena. The gangue minerals are quartz and calcite. The ore body pinches out with depth, 5 tons of ore might remain in the mine.

Boston Mine

The Boston mine is located in NESWNW 7-8S-17W at an elevation of 5,700

feet (1737m) and is owned by the William Barkely Estate. Workings consist of a shallow shaft and a prospect pit. The vein strikes N. 40° W. and dips 45 degrees southwesterly. Observed ore minerals are arsenopyrite, plumbojarosite, and scorodite. Some arsenates of iron, lead, and arsenic are also present. There are no reserves in the mine.

Success Mine

The Success mine is located in SWNESE 8- 8S-17W at an elevation of 5,550 feet (1692m) and is patented and owned by Clyde Wilson of Salt Lake City. The ore bodies of the Success mine are in veins in the Gold Hill stock which strike northwesterly and dip 30-45 degrees to the west. The veins are a few inches to four feet in thickness. The permanent water table was encountered at 65 feet (20m) and primary ore was found below. The oxidized ore near the surface consists of jarosite and plumbojarosite. Primary ore consists of arsenopyrite, galena, sphalerite, and tennantite. The principal gangue mineral is white, coarsely crystalline quartz. No reserves remain in the mine.

Climax Mine

The Climax mine is located on the north side of Rodenhouse Wash in NWNENW 17-8S-17W at an elevation of 5,300 feet (1615m). The mine and property composed of 12 patented claims is owned by Julian Simpson of Maori, Hawaii. The main workings consist of a vertical shaft, 150 feet (46m) deep, on a vein that strikes N. 82° W. and dips 89 degrees south. 250 feet (76m) of drifts and crosscuts have been driven from the shaft. Nolan (1935, p. 147) reports a shipment of two cars of ore containing 27 percent lead and 29 ounces of silver to the ton was made. Ore minerals are galena, sphalerite, and arsenopyrite. Gangue minerals are siderite, pyrite, and quartz. In 1976 the shaft was caved and flooded. There are no known reserves left in the mine.

Cash Boy or Mammoth Mine

The Cash Boy mine is located 1/2 mile (0.8km) southwest of the Calleo-

Gold Hill road in SWSWNE 9-8S-17W at an elevation of 5,450 feet (1661m). Floyd Meyers of Ibapah holds these claims by location. Two shallow shafts, 2,200 feet (670m) apart have been sunk on shear zones in quartz monzonite which contain lead-silver ore shoots. At the northern shaft an ore shoot strikes N. 80° W. and dips 60 degrees southwesterly. At the southern shaft the strike of ore is N. 50° W. and the dip is 40-60 degrees to the south. Mine development has not shown that these two shear zones are connected. Ore minerals are galena, sphalerite, arsenopyrite, anglesite, cerussite, and locally wulfenite. Gangue minerals are quartz and pyrite. There are no reserves left in the workings.

Cyclone Mine

The Cyclone mine is in Barney Reeves Gulch in NWNE 1-9S-18W at an elevation of 5,935 feet (1809m) and is held by Hilda and Danene Probert of Ibapah, Utah, by location. The workings consist of an inclined shaft from which a drift has been run for more than 400 feet (122m) at a depth of 80 feet (24m). The mineralization has also been explored by an adit, the portal of which is north of the shaft. Shipments of lead-silver ore were made in 1926.

A mineralized dike, that is 4 feet (3.1m) wide at the surface, contains plumbojarosite, galena, sphalerite, arsenopyrite, and chalcopyrite in a gangue of quartz, pyrite, and limonite. The host rock for the dike is the Gold Hill quartz monzonite stock. A composite of 11 samples from an ore shoot shows 0.03 ounces gold to the ton, 6 ounces silver to the ton, 0.4-8.2 percent lead, 0.5-1.7 percent copper, 0.5-3.8 percent zinc, and 0.5-7.3 percent arsenic. No reserves remain in the workings.

Midnight Adit (Copper Queen Midland Mining Co.)

The Copper Queen Midland Mining Co. property is staked by Floyd Meyers of Ibapah, Utah. Workings are located in NENENE 2-9S-18W at 6,250 feet (1905m). Several veins have been prospected by the Midnight adit, shallow pits and shafts. The Midnight adit has 620 feet (189m) of workings (figure 159). A vein is exposed along the entire length of the tunnel which ranges in width from 1-5 feet (0.3-1.5m) and strikes N. 15-30° E. and dips 25-40 degrees west. Ore minerals in the mine are arsenopyrite, galena, sphalerite, chalcopyrite, and plumbojarosite. Gangue minerals include jarosite, pyrite, limonite, and fragments of sericitized wall rock. No reserves remain in the Midnight adit.

Wilson Consolidated Mine

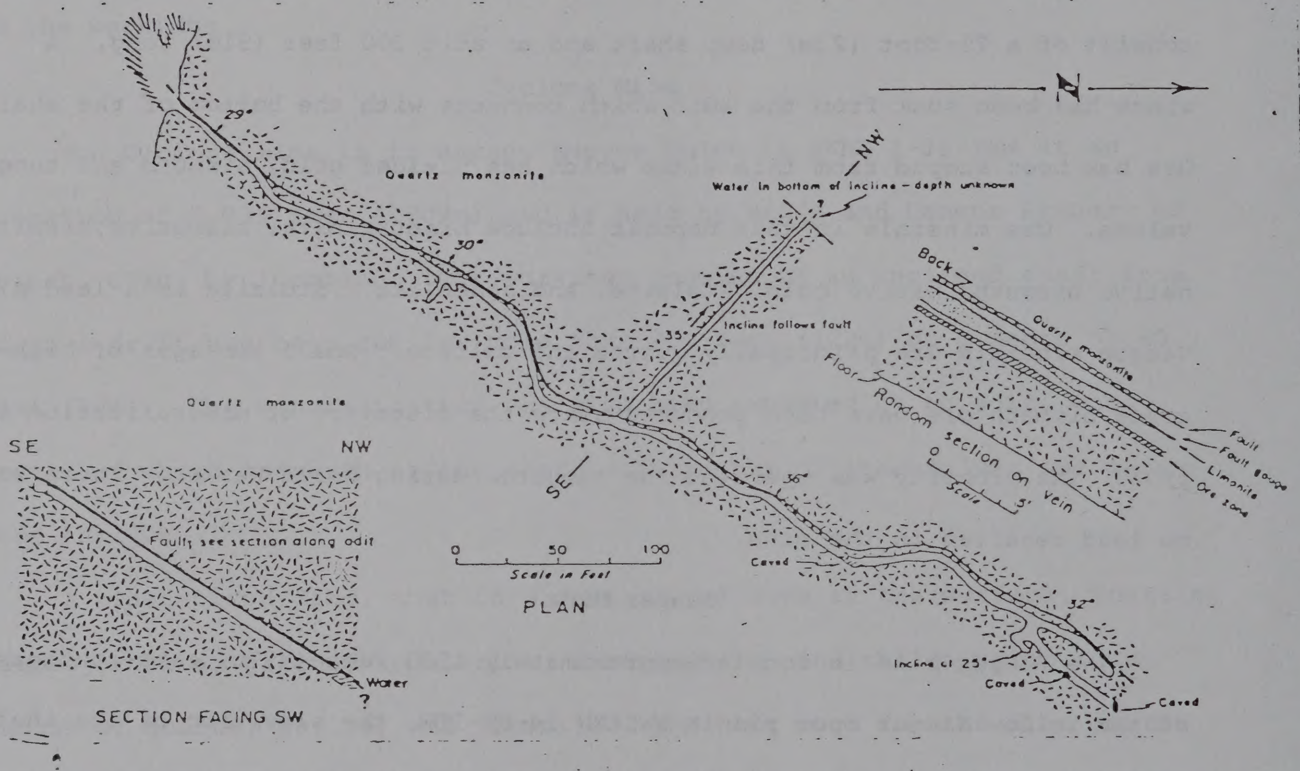
The Wilson Consolidate mine is located 2,500 feet (762m) south-southwest of the Yellow Hammer mine on the northeast side of Clifton Flat. The shaft collar is in SESENE 23-8S-18W at an elevation of 6,240 feet (1902m). Workings consist of a 75-foot (23m) deep shaft and an adit 300 feet (91m) long. A winze has been sunk from the adit which connects with the bottom of the shaft. Ore has been stoped from this winze which has yielded gold, bismuth and tungsten values. Ore minerals in this deposit include bismuthinite, bismutite,bismite, native bismuth, native gold, stolzite, and scheelite. Stolzite is a lead mineral. Gangue minerals are principally quartz and calcite. Small tonnages of high-grade bismuth ore have been produced since the discovery of mineralization in 1905. The property was operated for tungsten during World War II. There are no lead reserves in the mine.

Reaper Mine

The Reaper mine is located approximately 1500 feet (457m) east-southeast of the Yellow Hammer open pit in NWSESW 24-8S-18W, the elevation of the shaft collar is 6190 feet (1887m). The Reaper is developed by a vertical shaft, an open pit, and several prospect pits. The shaft is 105 feet (32m) deep and has two levels, one extending from the bottom of the shaft and the other extending from the shaft 56 feet (17m) higher (figures 160 and 161). The ore body is a pipe-like pegmatite and ore minerals are scheelite, molybdenite, small quantities of native gold, powellite, chalcopyrite, native copper, and galena. The main gangue minerals are quartz, actinolite, and orthoclase feldspar.

Figure 159:

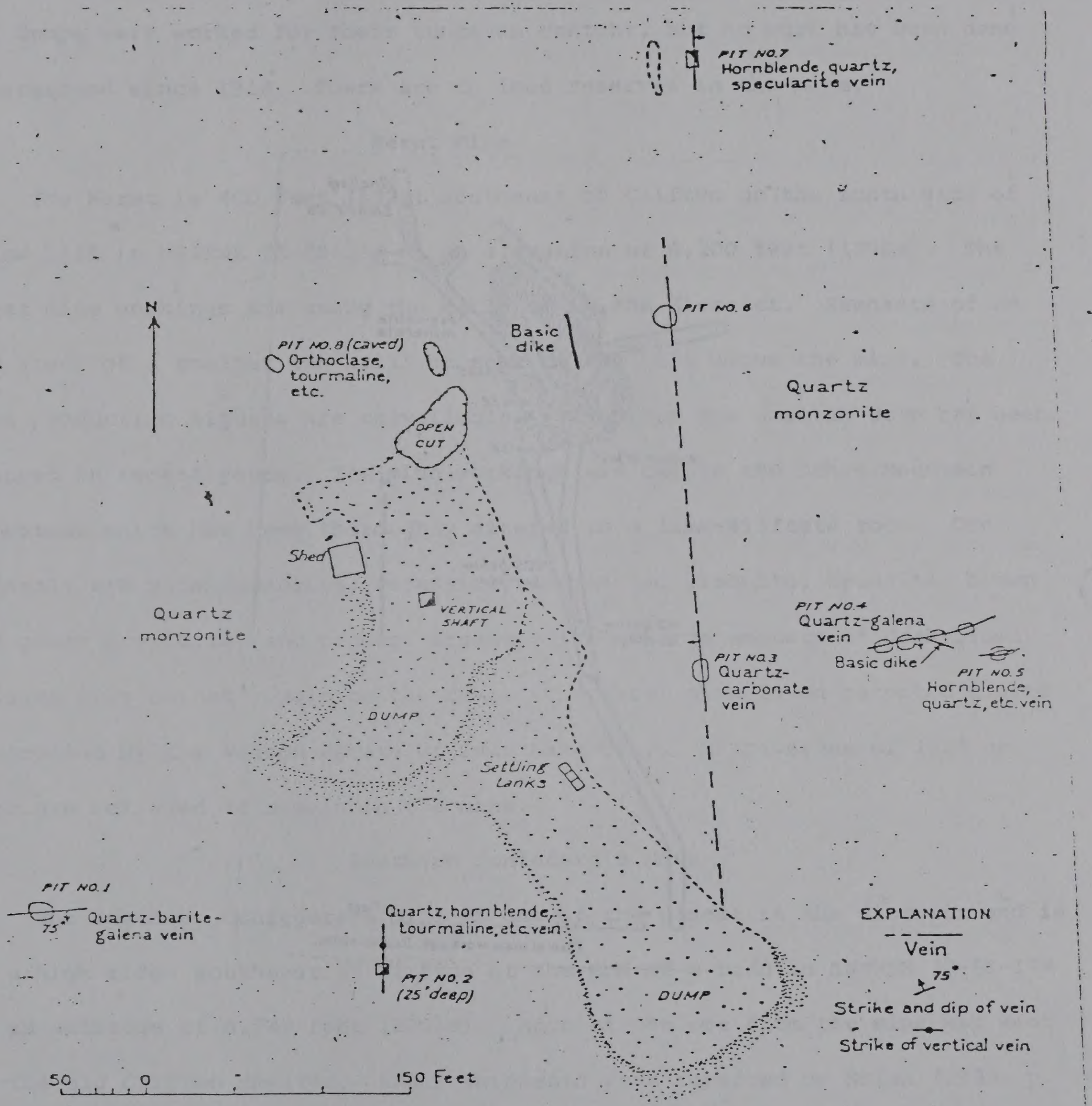
PLAN OF THE WORKINGS OF THE MIDNIGHT ADIT ON THE MIDLAND PROPERTY



Adapted from Thomson, 1973, p. 25

Figure 160:

SURFACE MAP OF THE REAPER MINE

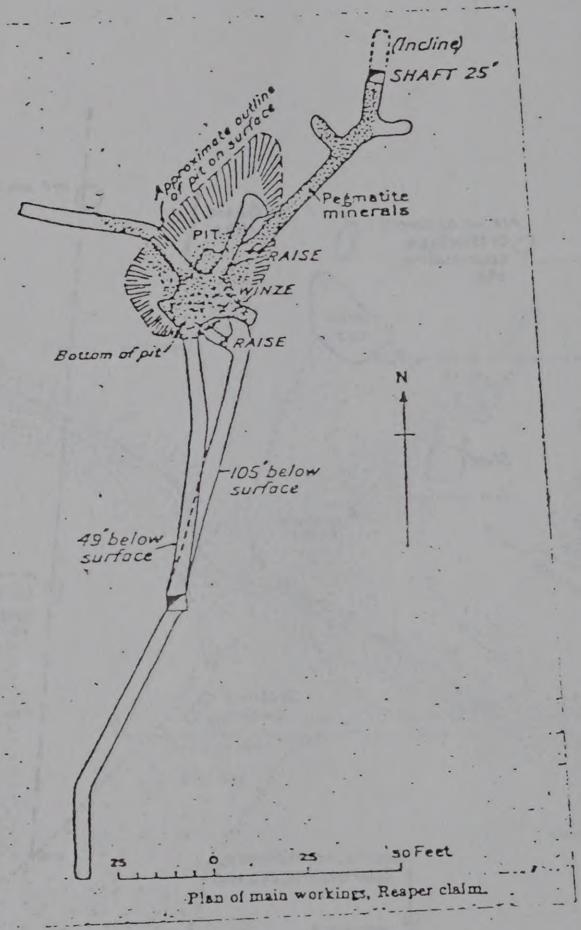


Prospect pits and mineralization adjacent to Reaper open cut.

Adapted from Nolan, 1935, p. 121

Figure 161:

PLAN OF THE MAIN LEVEL OF THE REAPER MINE



Adapted from Nolan, 1935, p. 170

Minor gangue minerals include tourmaline, hornblende, muscovite, chlorite, biotite, calcite, albite, spadaite, epidote, titanite, diopside, barite, zircon, magnetite, hematite, and jarosite. The Reaper property produced a moderate amount of high-grade tungsten ore during World War I. During World War II the dumps were worked for their tungsten content, but no work has been done underground since 1918. There are no lead reserves in the mine.

Herat Mine

The Herat is 400 feet (122m) southeast of Clifton on the south side of a low hill in NESENE 25-8S-18W at an elevation of 6,200 feet (1890m). The Herat mine workings are among the earliest in the district. Remnants of an old stack of a smelter can still be seen on the hill above the mine. The mine production figures are unavailable. Slag from the smelter dump has been shipped in recent years. The mine workings are cut in the Ochre Mountain Limestone which has been thoroughly altered to a lime-silicate rock. Ore minerals are plumbojarosite, cerussite, anglesite, limonite, hematite, brown and green scorodite, and perhaps arsenopyrite. Large amounts of dark-brown, massive iron oxides remain on the dump. The Herat mine is on patented claims controlled by the Watson Estate of Salt Lake City. No reserves of lead or zinc are believed to remain in the mine.

Southern Confederate Mine

The Southern Confederate mine is one of the oldest in the district and is on a high ridge southeast of Clifton at the end of a road in SWNWSE 30-8S-17W at an altitude of 6,742 feet (2055m). Much of the ore from the mine was sent to the old Clifton smelter. Small shipments were reported by Nolan (1935, p. 147) for 1918, 1919, and 1926 which averaged 30 percent lead and 30 ounces of silver to the ton. Zinc, copper, and arsenic were also present in small quantities. Ore is found in a shear zone up to 20 feet (6m) in width that strikes N. 50° E. and dips 75-80 degrees southeast. The Gold Hill quartz monzonite stock is the host, which is altered to a dark green. Alteration consists of sericitization and introduction of fine-grained quartz and chlorite. In the shear zone, lenses of lead ore as much as 2 feet in width and up to 50 feet (15m) in length have been found. Development consists of a 150-foot (46m) deep shaft on the vein. Ore minerals are anglesite, cerussite, plumbojarosite and galena. Anglesite is the most abundant lead mineral. Small amounts of azurite and malachite are also present in the ore. Gangue minerals are coarsely-crystalline quartz and limonite pseudomorphs after pyrite. Coarse breccias in the vein and gouge in the ore shoots were formed by post-mineral faulting. There are no known reserves remaining in the mine.

Red Jacket Mine

The Red Jacket mine is located near the top of a hill less than a half mile (0.8km) southeast of Clifton and immediately north of the Southern Confederate claim in SWNWNE 30-8S-17W at 6775 feet (2065m) above sea level. The Red Jacket claim is patented and workings consist of several tunnels and at least one winze. Perhaps 500 feet of workings are on the property. In one of the tunnels a winze was sunk on the vein and at a depth of 180 feet (55m) an eastward dipping fault terminated the ore. The host rock is the Gold Hill quartz monzonite stock. Ore minerals include anglesite, cerussite, galena, green crystalline mimetite, wulfenite, and plumbojarosite. Gangue minerals are quartz, pyrite, limonite, and jarosite. No reserves remain in the mine.

Bird Mine

The Bird mine is located on the Southern Confederate mine vein to the east in SWNESW 30-8S-17W at an elevation of 6,650 feet (2067m). Workings consist of an adit driven southwesterly along the vein which strikes northeast and dips 75 degrees southeasterly. The claims are held by Julian Simpson of Maori, Hawaii. Ore minerals are anglesite, cerussite, plumbojarosite, galena, malachite and azurite. Gangue minerals are quartz, limonite and jarosite.

No reserves remain in the mine.

Monocco Mine

The Monocco property lies 5.5 miles (8.8km) south of Gold Hill and 10 miles (16km) northeast of Ibapah. The mine is in NENE 36-8S-18W at an elevation of 6,840 feet (2085m). The property is composed of 12 patented claims owned by Floyd Meyers of Ibapah, Utah, and was first worked in 1917. Between 1917 and 1920 786 tons of copper and lead-silver ore averaging 10.17 percent copper, 3.52 ounces silver, 0.002 ounces gold and 0.88 percent lead were mined. The property continued to be worked intermittently in the late 1920s and 1930s. Mine workings consist of an inclined shaft, several adits, four open pits and numerous prospect pits (figures 162 and 163). Mineralization consists of vein and bedded replacement deposits in the Oquirrh Formation. The veins strike N. 45° E. and dip 60-90 degrees northwesterly, are 1-6 feet (0.3-2m) wide and are exposed 100-1200 feet (30-366m) along strike. The replacement deposits are in a select bed near the contact with the underlying intrusive. Minerals include galena, cerussite, plumbojarosite, malachite, chrysocolla, native copper, azurite, pyrite, limonite, hematite and quartz. The mine has a potential reserve of several hundred tons of lead-copper ore.

References:

Butler, B. S. and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672 p.

El-Shatoury, H. M. and J. A. Whelan, 1970, Mineralization in the Gold Hill mining district, Tooele County, Utah: Utah Geol. and Mineral Survey Bull. 83, 37p.

Hintze, L. F., 1973, Geologic history of Utah: Brig. Young Univ. Geol. St., v. 20,pt. 3, 181p.

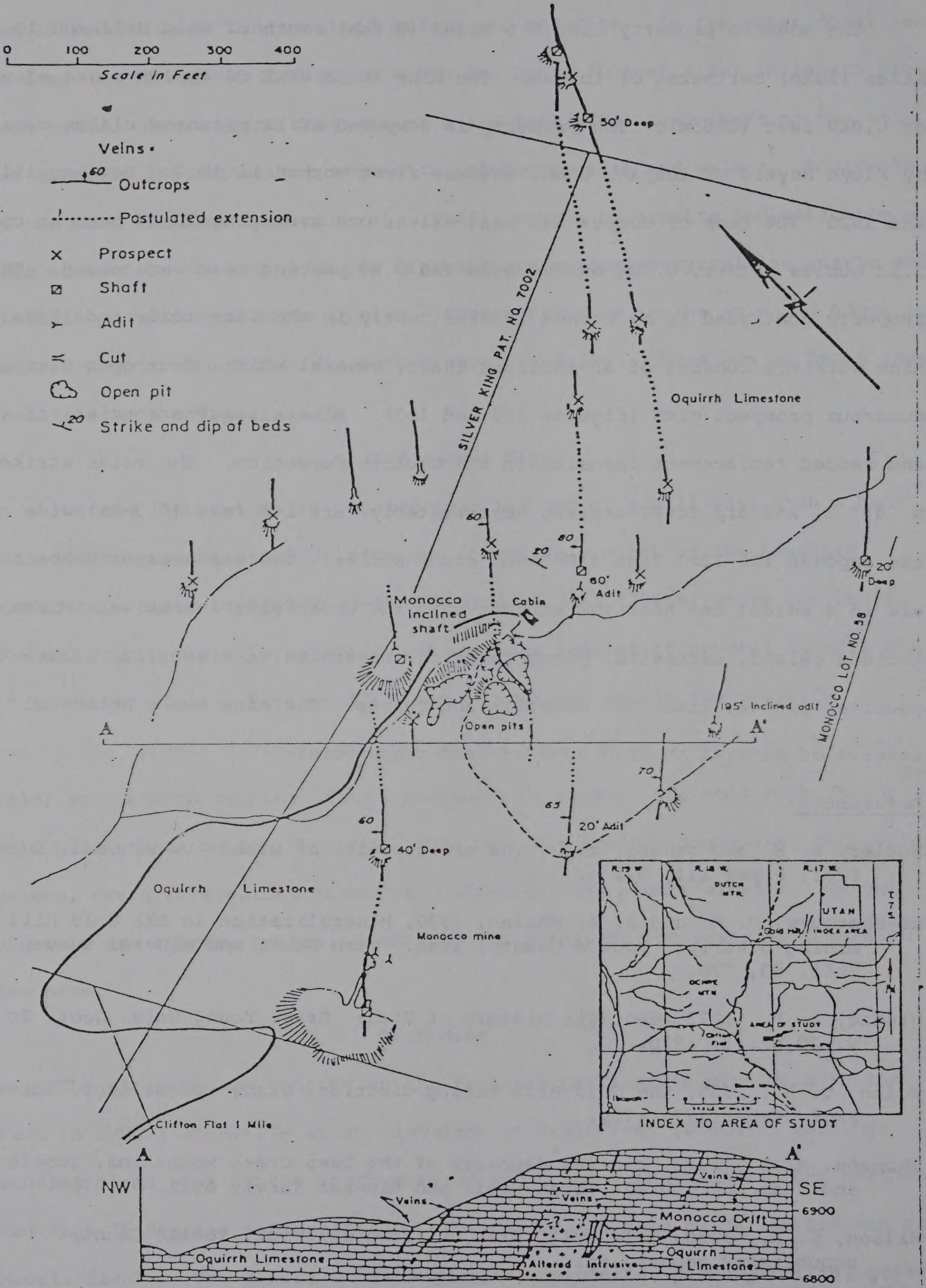
Nolan, T. B., 1935, The Gold Hill mining district, Utah: U. S. Geol. Survey Prof. Paper 177, 172p.

Thomson, K. C., 1973, Mineral deposits of the Deep Creek Mountains, Tooele and Juab Cos., Utah: Utah Geol. and Mineral Survey Bull. 99, 76p.

Wilson, S. R., 1958, Gold Hill, Utah, Clifton district, Tooele County: unpublished report, 8p.

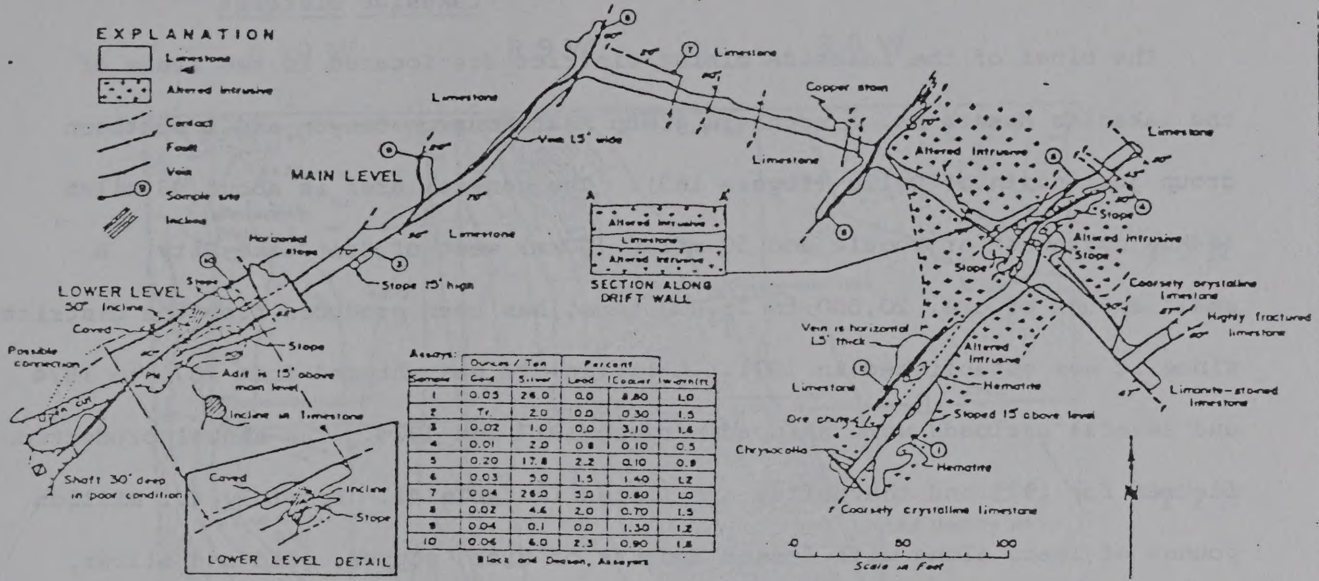
Figure 162:

SURFACE GEOLOGY AND VEIN SYSTEM OF THE MONOCCO PROPERTY



Adapted from Thomson, 1973, p. 25

PLAN AND SECTIONS OF THE MONOCCO PROPERTY

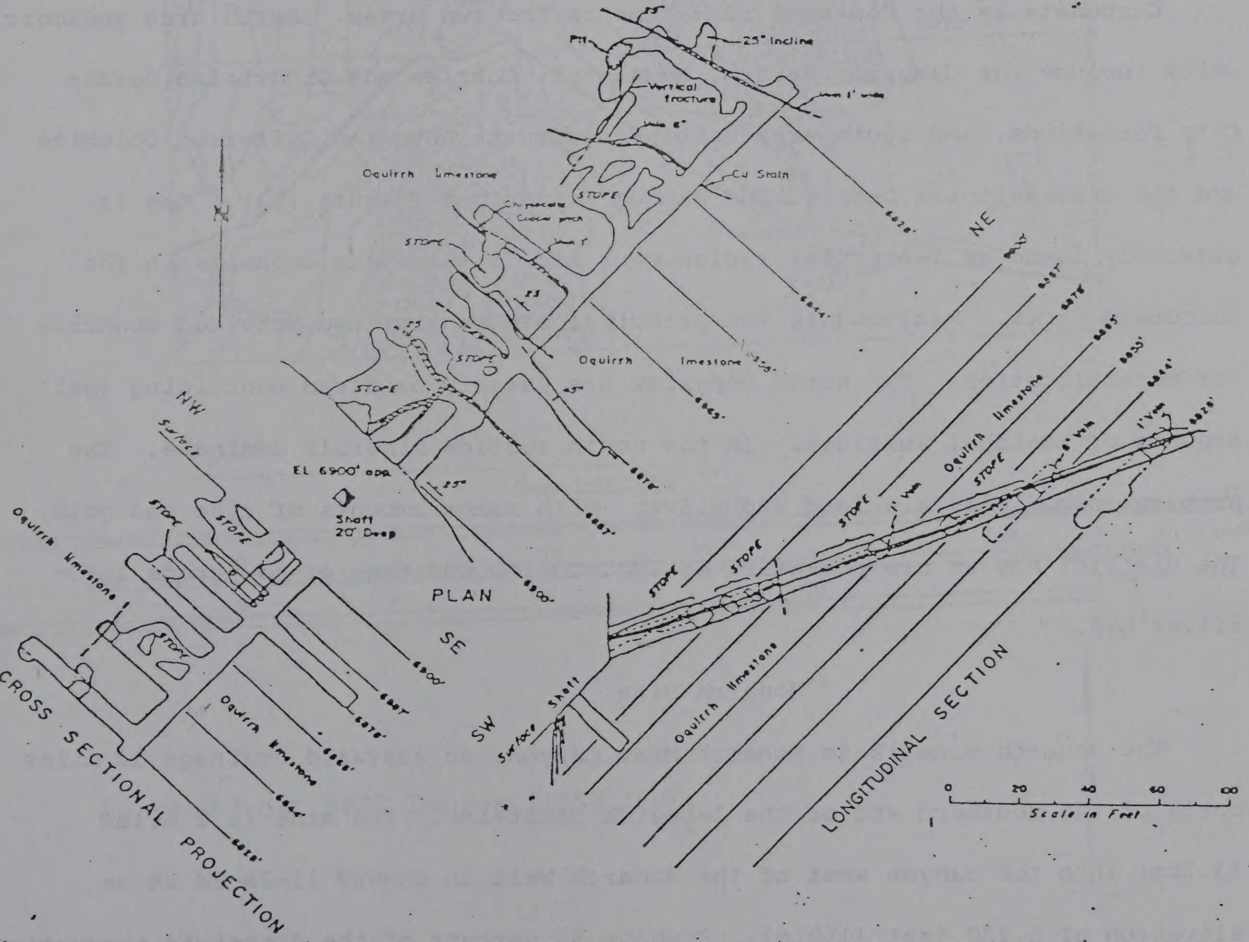


Assays:

Sample	Ounces / Ton		Percent		
	Gold	Silver	Lead	Copper	Width (ft)
1	0.05	26.0	0.0	8.80	1.0
2	Tr.	2.0	0.0	0.30	1.5
3	0.02	1.0	0.0	3.10	1.6
4	0.01	2.0	0.8	0.10	0.5
5	0.20	17.8	2.2	0.10	0.8
6	0.03	3.0	1.5	1.40	1.2
7	0.04	26.0	3.0	0.80	1.0
8	0.02	4.6	2.0	0.70	1.5
9	0.04	0.1	0.0	1.30	1.2
10	0.06	6.0	2.3	0.90	1.8

Black and Deeson, Assayers

Figure 10. Geologic map and assay data of the Monocco mine.



Adapted from Thomson, 1973, p. 22

Lakeside District

The mines of the Lakeside mining district are located in two areas of the Lakeside Mountains; a northern group near Monarch Canyon and a southern group just north of Delle (figure 163). The general area is about 40 miles (64km) northwest of Tooele and 50 miles (80km) west of Salt Lake City. A small amount of ore, 20,000 to 25,000 tons, has been produced from the district since it was established in 1871. A little ore was shipped from 1871 to 1874 and several carloads were shipped between 1917 and 1924. The annual production figures for 1925 and thereafter are listed in table 41. Possibly 4.1 million pounds of lead, along with lesser amounts of zinc, copper, gold and silver, were produced from the district (Doelling, 1964, p. 332).

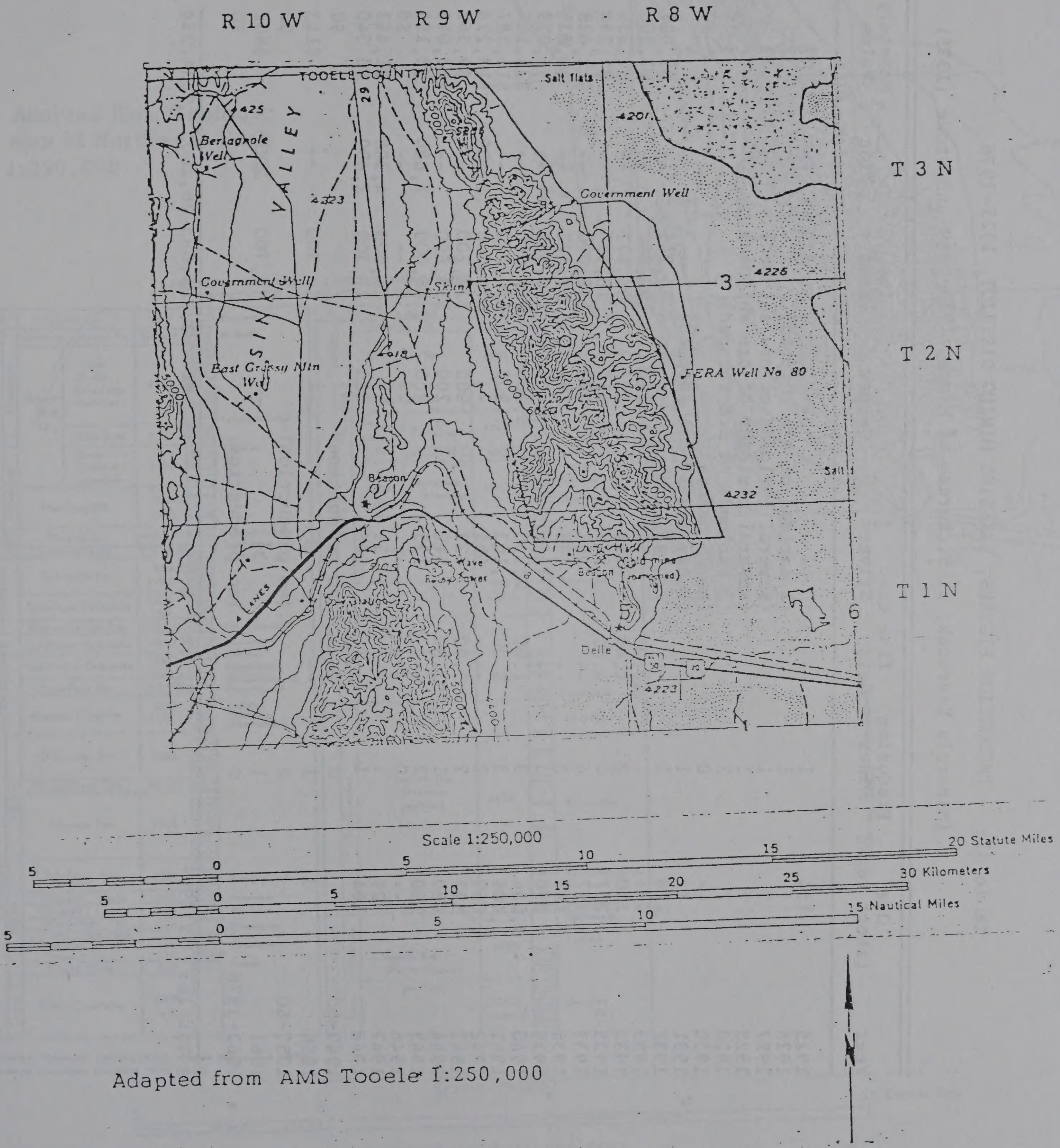
Carbonate is the dominant rock type in the two areas. North area geologic units include the Cambrian Marjum, Nounan-St. Charles and Ordovician Garden City Formations, and south area units include the Devonian Jefferson Dolomite and the Mississippian Deseret and Humbug Formations (figure 164). Ore is generally found as lenticular replacement and fissure vein deposits in the carbonate rocks. Faulting is the principal ore control and provided conduits for mineralization. The north deposits are largely oxidized containing small amounts of residual sulfides. In the south sulfide minerals dominate. The primary commodities are lead and silver, with minor amounts of zinc and gold. The district has an ore potential of 100,000-200,000 tons of low-grade lead-silver ore.

Monarch Mine

The Monarch mine is in Monarch Mine Canyon, an eastward drainage 12 miles north of the southern end of the Lakeside Mountains. The mine is 2 miles (3.2km) into the canyon west of the Monarch Well in SENWNW 11-2N-9W at an elevation of 5,220 feet (1591m). Perhaps 90 percent of the districts production can be assigned to this mine. Access to the Monarch mine is through an adit 1,200 feet (366m) in length, and two inclined shafts. Raises and winzes extend

Figure 163:

LOCATION MAP OF THE LAKESIDE MINING DISTRICT



Adapted from AMS Tooele I:250,000

Table 41: PRODUCTION FIGURES, LAKESIDE MINING DISTRICT, 1925-1976

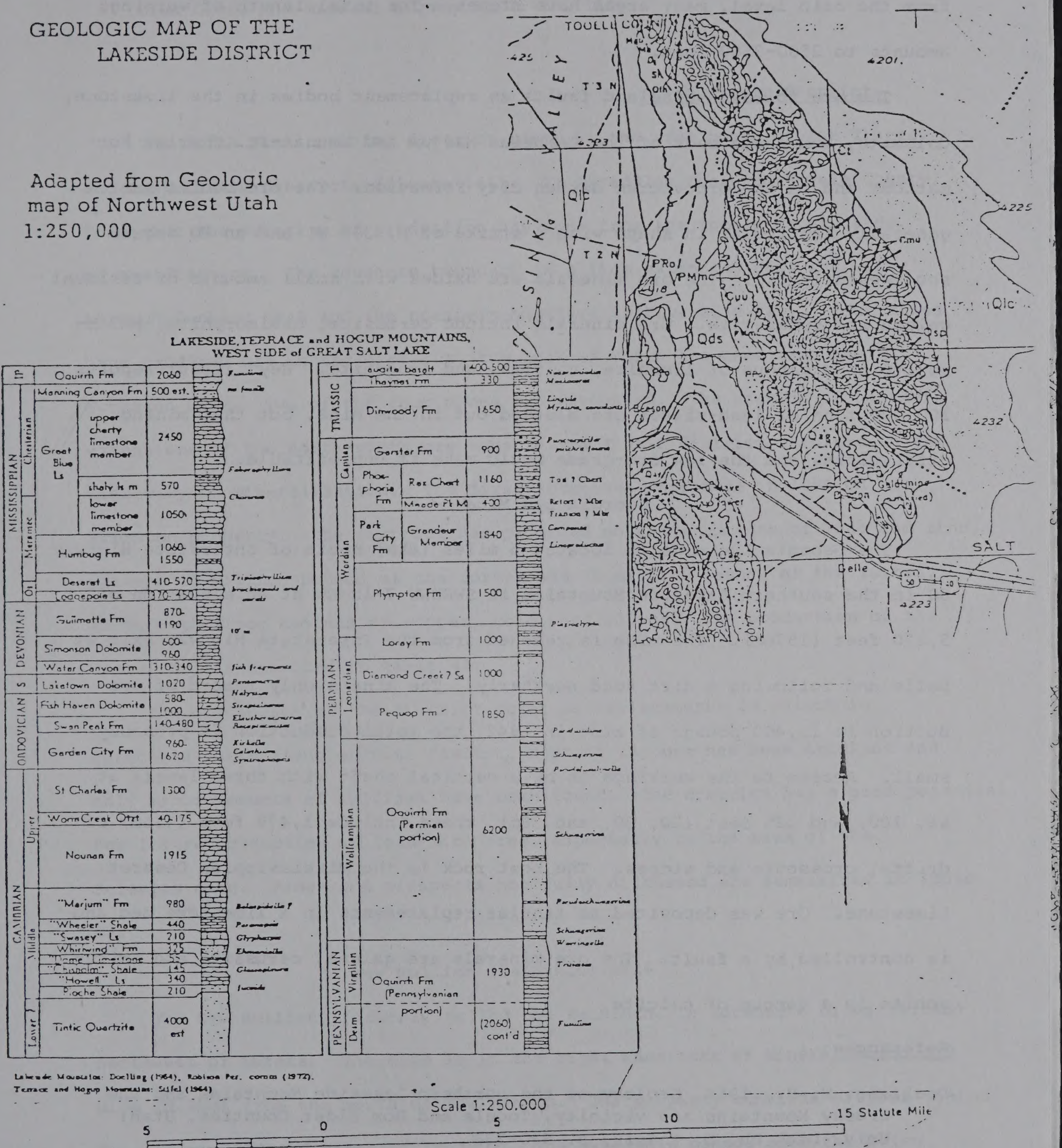
(Minerals Yearbook, U. S. Bureau of Mines, 1925-1959 and Stowe (1975)

			fine ozs.			lbs.		
Year	Ore (short tons)	Producing Mines	Gold	Silver	Copper	Lead	Zinc	Monetary Value
1925	154	1	--	--	--	59,877	--	?
1926	?	1		(1 carload of ore shipped)				?
1927	?	1		(several carloads of ore shipped)				?
1928	?	1		(several carloads of ore shipped)				?
1929	?	2		(3 carloads of ore shipped)				?
1930	--	0		(no shipments)				$0
1931	?	1		(1 carload of ore shipped)				?
1932	178	1	--	248	--	65,255	--	$2,027
1933	495	1	83.0	564	724	193,887	--	$7,500
1934	200	2	1.49	368	537	54,675	--	$2,356
1935-6	237	3	0.60	249	313	78,950	--	$3,384
1937	3,627	4	--	905	380	198,000	--	$12,428
1938	149	3	--	198	204	58,478	--	$2,838
1939	390	3	--	461	423	120,681	--	$6,029
1940	3,034	3	1.00	2,160	3,000	665,080	--	$35,164
1941	1,406	3	2.00	1,163	2,200	270,700	--	$16,587
1942	1,059	2	--	585	--	175,400	11,400	$13,228
1943	527	2	2.00	329	900	122,200	--	$9,586
1944	680	1	3.00	512	1,200	155,800	--	$13,095
1945	160	2	--	135	200	26,000	7,880	$3,164
1946	--	0	--	--	--	--	--	$0
1947	29	1	--	31	--	6,000	4,300	$1,413
1948	164	1	--	106	200	27,300	2,400	$5,340
1949-55		0		(no production)				$0
1956	1	1	--	3	--	700	--	$113
1957-60		0		(no production)				$0
1961	?	1	--	34	--	5,700	200	$682
1962-1976		0		(no production)				$0
Totals:	12,490+		93.09	8,051	10,281	2,284,683	26,160	$134,934

Figure 164:

GEOLOGIC MAP OF THE LAKESIDE DISTRICT

Adapted from Geologic map of Northwest Utah 1:250,000



Lakeside Mountains: Doelling (1964), Robison Per. comm. (1972).
Terrace and Hogup Mountains: Stifel (1964)

from the main level, many areas have stopes. The total length of workings amounts to 2500-3500 feet.

The ore follows veins and faults as replacement bodies in the limestone, dolomite, and shale beds of the Cambrian Marjum and Nounan-St. Charles Formations and in the Ordovician Garden City Formation. The ore bodies are generally lenticular in shape with a strike of N. 30° W. and an 80 degree southwesterly dip. The ore minerals are oxides with small amounts of residual galena and sphalerite. Ore minerals include cerussite, hemimorphite, smithsonite in a gangue of limonite, calcite, and aragonite. Heyl (1964) reports 100,000 tons of lead-silver ore blocked out in the mine, but that mining difficulties and the low ore-grade would make it unprofitable.

Georgia Lyn Mine

The Georgia Lyn mine is located 5 miles (8km) north of Interstate Highway 80 in the southern Lakeside Mountains in SWNENW 7-1N-8W at an elevation of 5,170 feet (1576m). The mine is reached from the Interstate Highway exit at Delle and following a dirt road northerly. The mine's only record of production is 11,400 pounds of zinc in 1942, the total production is probably small. Access to the workings is by a vertical shaft with three levels at 65, 100, and 125 feet (20, 30, and 38m), these include 1,479 feet (451m) of drifts, crosscuts and stopes. The host rock is the Mississippian Deseret Limestone. Ore was deposited as tabular replacements in a limestone bed and is controlled by a fault. The ore minerals are galena, cerussite and smithsonite in a gangue of calcite.

References:

Doelling, H. H., 1964, Geology of the northern Lakeside Mountains and the Grassy Mountains and vicinity,' Tooele and Box Elder Counties, Utah: Univ. Utah Ph. D. thesis, p. 330-338.

Heyl, A. V., 1963, Oxidized zinc deposits of the United States, pt. 2, Utah: U. S. Geol. Survey Bull. 1135B, p. B56-58.

Teselle, Roger, 1974, Geology and ore deposits of southern Lakeside mining district: unpublished report.

Young, J. C., 1955, Geology of the southern Lakeside Mountains, Utah: Utah Geol. and Mineral Survey Bull. 56, 110p.

North Tintic District

The North Tintic mining district takes in the area north of the Tintic and East Tintic districts (figure 165). It straddles the Utah-Tooele County line, but the majority of production has come from the Tooele County side of the district. The southern boundary is a line extending east and west through Packard Peak and the northern boundary is Five-Mile Pass. Four mines have produced ore in the district, the bulk of which has come from the Scranton mine. Two of the four mines are discussed. The seeking of northern extensions of the north-south ore runs in the Tintic district resulted in the discovery of mineralization. The first locations were made in 1886 on the Scranton property. The district has produced moderate amounts of lead and zinc, perhaps 15 million pounds of the former and 25 million pounds of the latter, along with minor amounts of copper, gold, and silver. The production of the district is summarized in table 42.

The ore bodies of the district occur as replacements in Paleozoic carbonate rocks along or near faults. Most of the ore has been oxidized and only minor amounts of sulfides have been found. The district has a good potential for future production of lead-zinc ores, especially in the area of the Scranton mine. Mines and prospects not fully discussed are summarized in table 43.

New Bullion (Balhinch) Mine

The New Bullion, formerly called the Balhinch, is located 6 miles (9.6km) northwest of Eureka. The mine is in the right hand fork of Miners Canyon 1/2 mile (0.8km) from the mouth of the canyon. The property consists of four claims located in 1887 and patented in 1902. The ownership passed from the Helen Mining Co. to the New Bullion Mining Co. in 1905. Surface ores, valued at

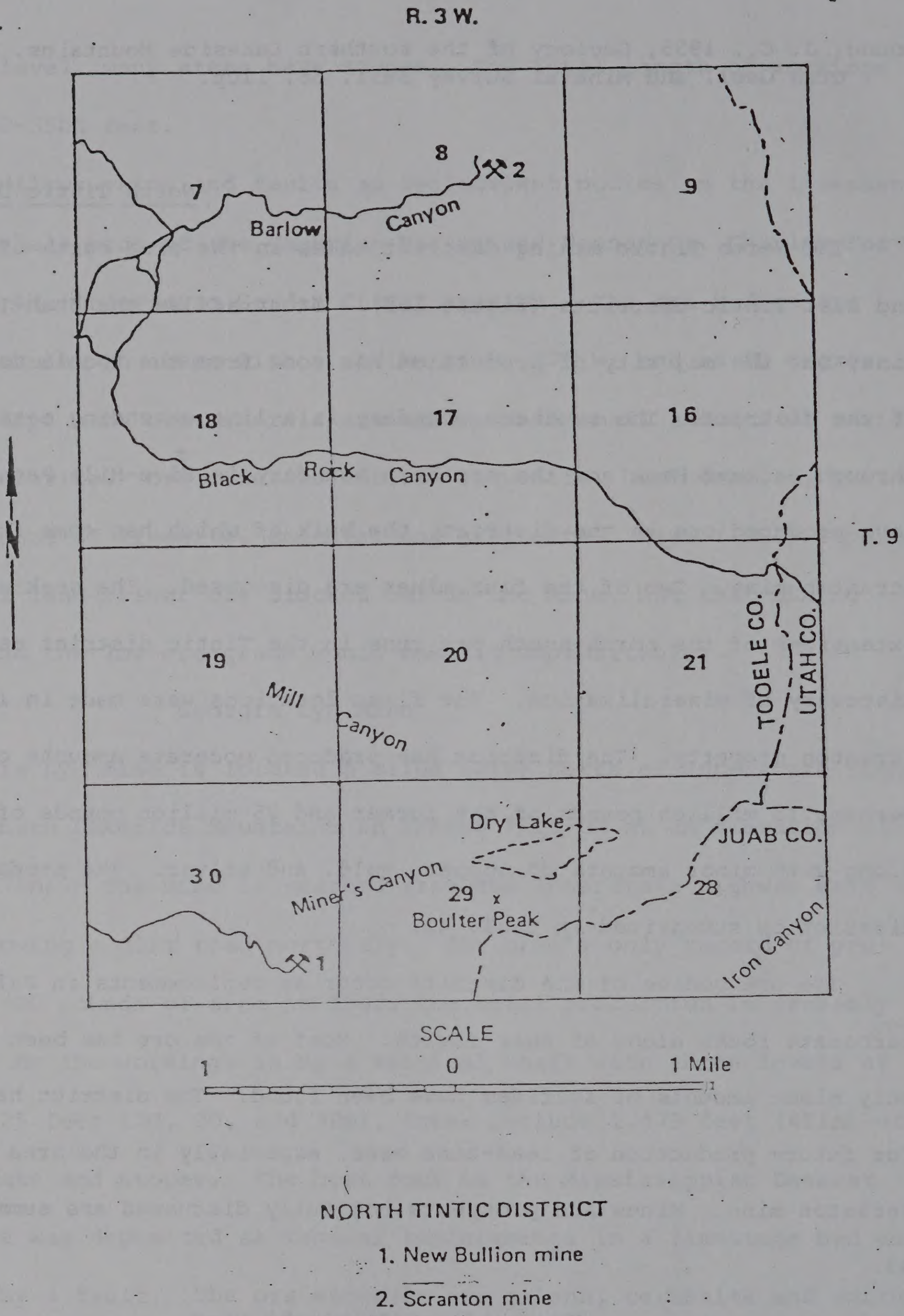


Figure 165: Outline map of North Tintic mining district

Adapted From: USGS Boulter Peak 7½' Quadrangle

Table 42: Lead, zinc, copper, gold, and silver production from North Tintic mining district, 1902-1976:

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1902	352	340,850	---	---	---	526	$14,254
1903	437	287,482	---	---	3.58	654	12,501
1904	385	310,409	---	---	---	741	14,004
1905	2,000	1,400,000	---	---	---	6,000	69,424
1906	7,113	956,060	2,176,200	---	2.75	5,777	191,171
1907	10,765	953,759	4,154,988	---	---	2,534	297,366
1908	1,138	663,708	---	---	---	2,336	29,114
1909	4,028	389,427	1,817,542	---	---	994	115,409
1910	6,347	549,069	2,843,032	---	0.21	969	178,210
1911	9,020	2,313,093	4,118,414	182	1.13	2,909	340,427
1912	4,979	1,769,623	860,222	---	---	4,410	143,398
1913	918	125,875	416,922	---	---	246	29,132
1914	212	76,293	19,730	---	---	121	4,102
1915				no production			
1916	4,051	179,686	1,730,645	---	---	270	244,574
1917	4,738	1,091,346	654,601	---	---	4,033	164,658
1918		"large output of lead-zinc ore"					
1919		"considerable zinc and some lead produced"					
1920		"oxide zinc ore shipped from the Scranton mine"					
1921-1925				no production			
1926		"a little lead-zinc ore shipped from the New Bullion and Scranton mines"					
1927		"2 cars of ore shipped from New Bullion and 1 car from the Scranton mine"					
1928-1932				no production			
1933		"less than 5900 pounds of lead produced, no zinc					
1934-1936				no production			
1937	245	30,000	84,000	---	---	84	7,295
1938	118	18,739	40,979	51	---	65	2,876
1939	30	13,383	---	---	---	28	648
1940	51	23,600	---	168	1.00	69	1,283
1941	396	13,400	113,600	---	---	52	9,283
1942	109	12,600	8,700	---	---	59	1,695
1943	35	3,600	5,500	---	1.00	62	943
1944	30	1,200	5,500	---	---	---	723
1945	45	1,500	9,200	---	---	45	1,219
1946	2,900	210,000	366,000	2,500	10.00	1,464	69,480
1947	633	40,000	86,000	400	1.00	390	16,638
1948-1976				no production			
Totals	61,075+	11,774,702+	19,511,775+	3,301+	20.67+	38,857+	$1,959,865+

Table 43: Prospects in the North Tintic mining district

Prospect	Location	Remarks
Lehi-Tintic mine	NW22-9S-2W	Oxidized lead minerals in a gangue of jasperoid and dolomite, occurs in fissures in footwall block of Lehi-Tintic fault. A small quantity of ore shipped, content of silver low.
Tintic-Prince	NE33-9S-3W	Ore is pyrite, galena and quartz replacing fault gouge in brecciated zones along normal faults.
Hot Stuff	SW¼ sec. 22, T. 9 S., R. 3 W.	Films and veinlets of copper pitch in crumpled shale; deposit is explored by pits, an adit, and 2 inclined shafts. Area is favorably regarded from standpoint of exploration possibilities.
Tintic-Humbolt	NE¼ sec 13, T. 9 S., R. 3 W.	Lead, zinc and silver reported in calcite veinlets in fault zone; explored by 2 shafts.*
Deprezin	E½ sec. 25, T. 9 S., R 3 W.	Some bismuth and traces of gold and silver reported in north-northwest trending jasperoid mass; explored by drifts from a shaft.*
Farragut	SE¼ sec. 36, T. 9 S., R. 3 W.	Lead, copper, silver and gold reported in jasperoid; deposit is explored by an adit and shaft.*
Balhinch	SW¼ sec. 29 and NW¼ sec. 32, T. 9 S., R. 3 W.	Oxidized lead and zinc ore was mined from small near-surface ore bodies in unaltered Madison limestone. Ore is similar, and probably related to New Bullion ore bodies. Quantity of ore produced not known, but believed to be small.
Silver Bell	NW¼ NE¼ sec. 5, T. 10 S., R. 3 W.	Copper carbonate minerals occur with calcite in brecciated dolomite along a northwest-trending fissure that is close to a fault of large displacement. Rocks adjacent to large fault considerably altered. Area may warrant further exploration.
Selma	E½ sec. 28, T. 9 S., R. 2 W.	Small quantities of lead and precious metals in large cavernous pipe of low-grade iron ore; explored by an adit and drifts from a shaft.*

---

*Data from Lindgren, Loughlin and Heikes (1919).

$35,000 net in lead and zinc, were mined from the property in 1897 (Butler and others, 1920, p. 416). Small and sporadic shipments of ore between 1906 and 1955 totaled 1528 tons containing 2,364 ounces silver, 261,257 pounds lead and 388,518 pounds of zinc. This ore averaged 8.5 percent lead, 12.7 percent zinc, and 7.2 ounces of silver to the ton (Disbrow and Morris, 1957, p. 141).

The New Bullion area is underlain by sedimentary rocks ranging in age from Late Ordovician to Late Mississippian (figure 166). Mineralization is in the lower member of the Madison Limestone and occurs as small bunches of ore along north-trending fissures (Lindgren and Loughlin, 1919, p. 273). The ore bodies are localized along fractures with small displacements in the hanging wall block of the New Bullion fault. Minerals in the ore are cerussite, smithsonite, hemimorphite, galena, sphalerite, limonite, calcite, dolomite, and quartz. Disbrow and Morris (1957, p. 144) mention a body of oxidized ore,containing 2,700 tons, that might remain in the mine. There are no other reserves in the mine.

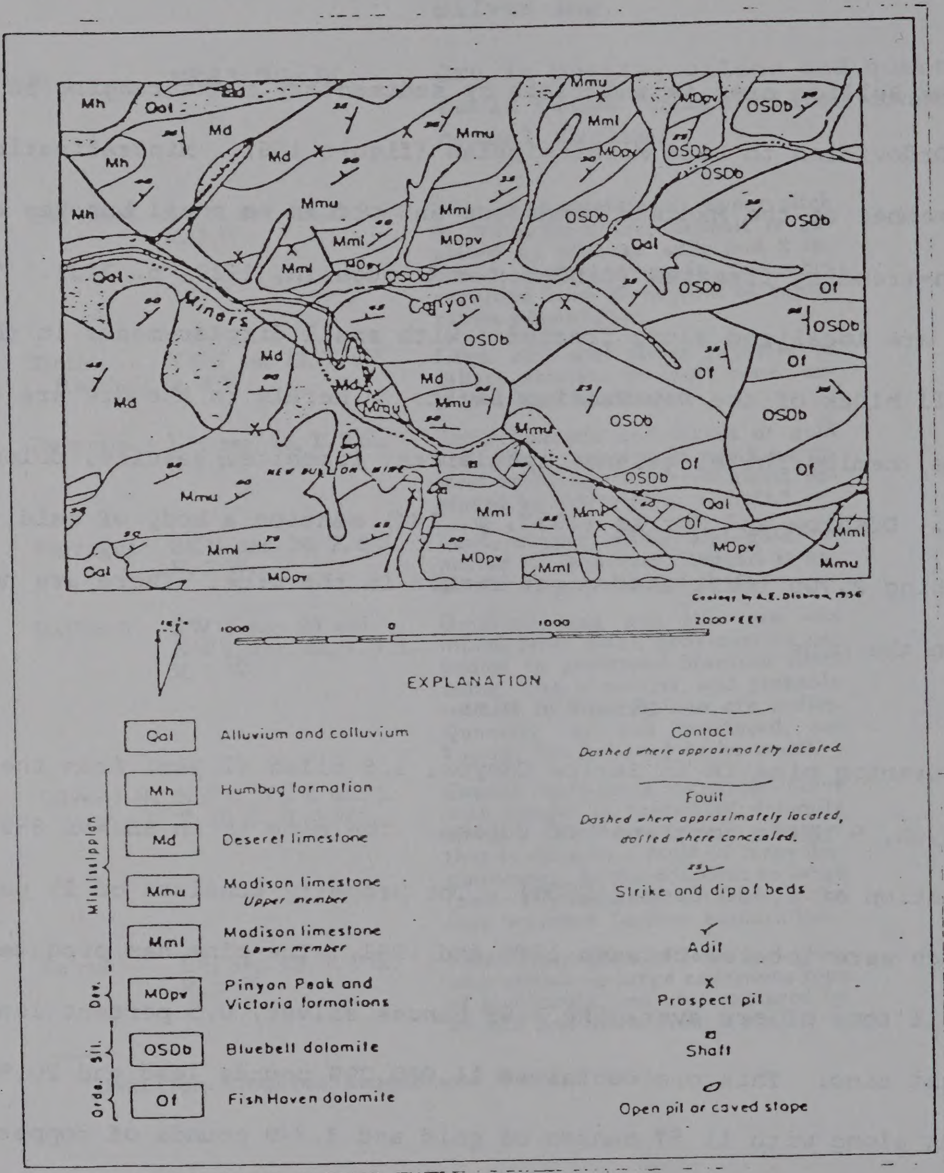
Scranton Mine

The Scranton mine is in Barlow Canyon, 1.5 miles (2.4km) from the mouth of the canyon, 9 miles northwest of Eureka. The mine is in SESWNE 8-9S-3W at an elevation of 6,430 feet (1960m). The property consists of 25 patented claims which were located between 1886 and 1891. The mine has produced at least 62,411 tons of ore averaging 0.69 ounces silver, 0.5 percent lead, and 16.7 percent zinc. This ore contained 11,900,099 pounds lead and 20,920,306 pounds zinc along with 11.57 ounces of gold and 3,749 pounds of copper. The gold and copper of most of the ore was not recovered. Most of the production came before 1950.

The ore bodies of the Scranton mine are associated with the north-south trending Scranton fissure (figure 166a)and are replacements of the Mississippian Madison Limestone. The ore bodies are nearly all oxidized and consist of

Figure 166:

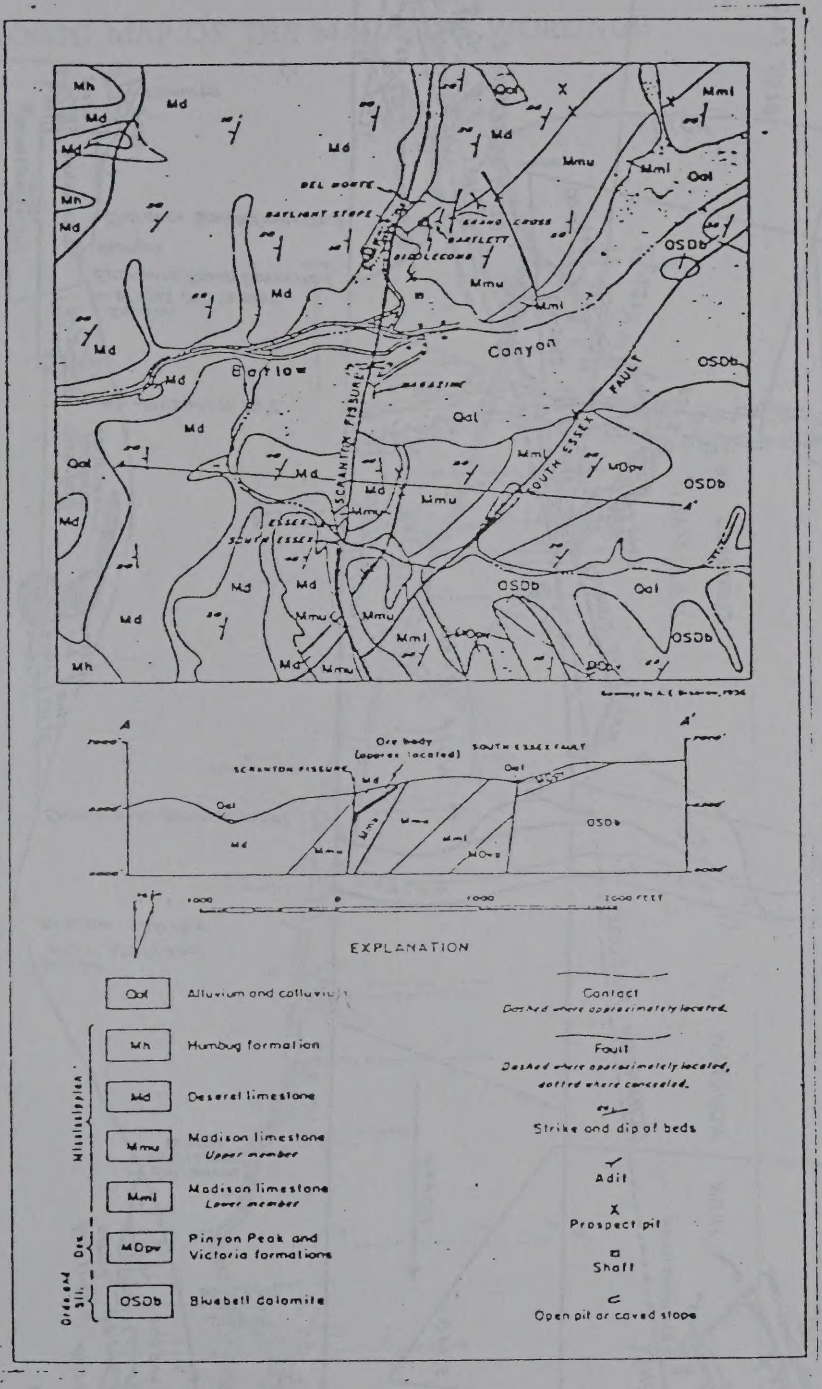
GEOLOGIC MAP OF THE NEW BULLION MINE AREA



Adapted from Disbrow and Morris, p. 145

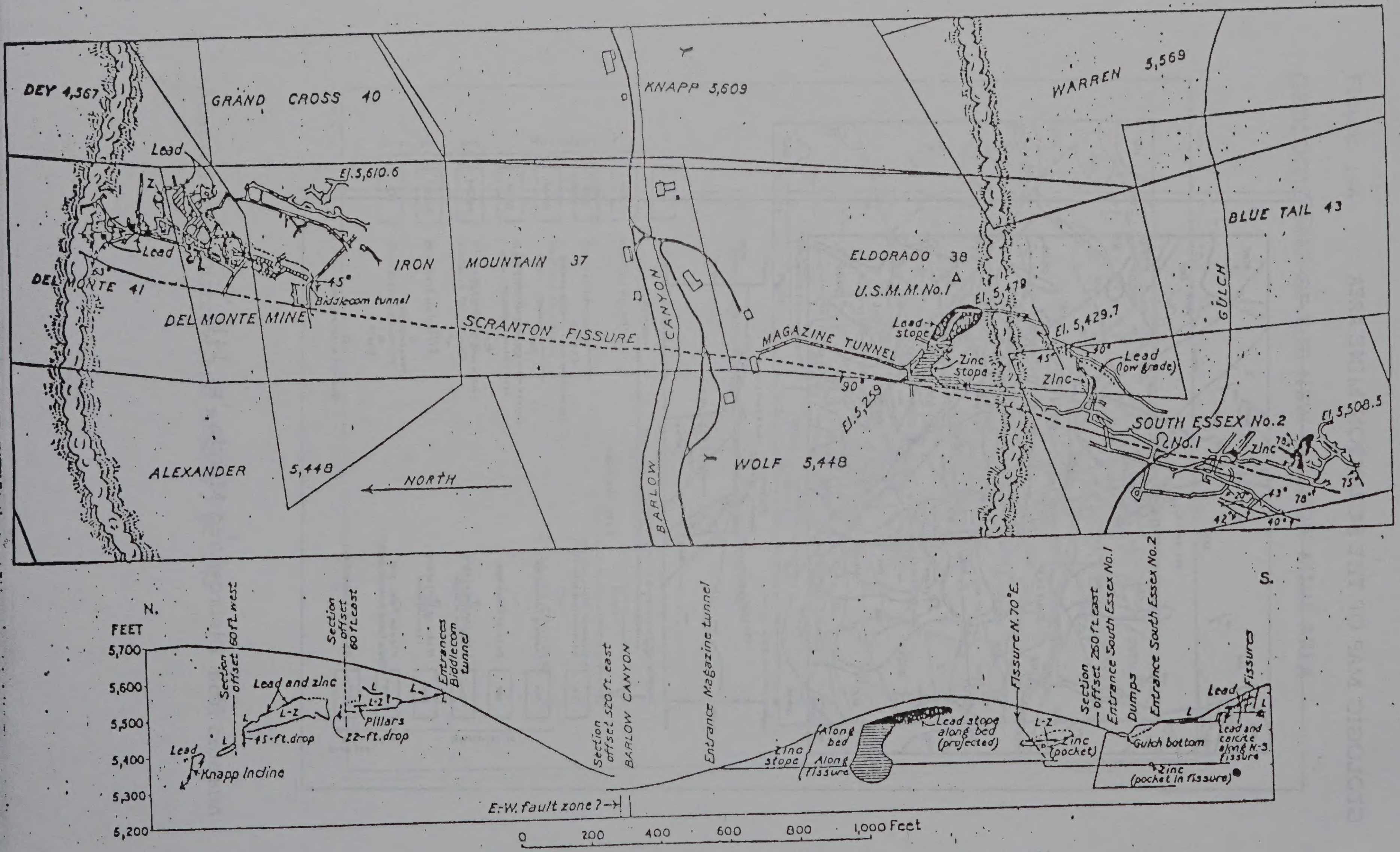
Figure · 166a:

GEOLOGIC MAP OF THE SCRANTON MINE AREA



Adapted from Disbrow and Morris, p. 141

Figure 167: PLAN AND LONGITUDINAL PROFILE OF ORE BOKIES IN SCRANTON MINES

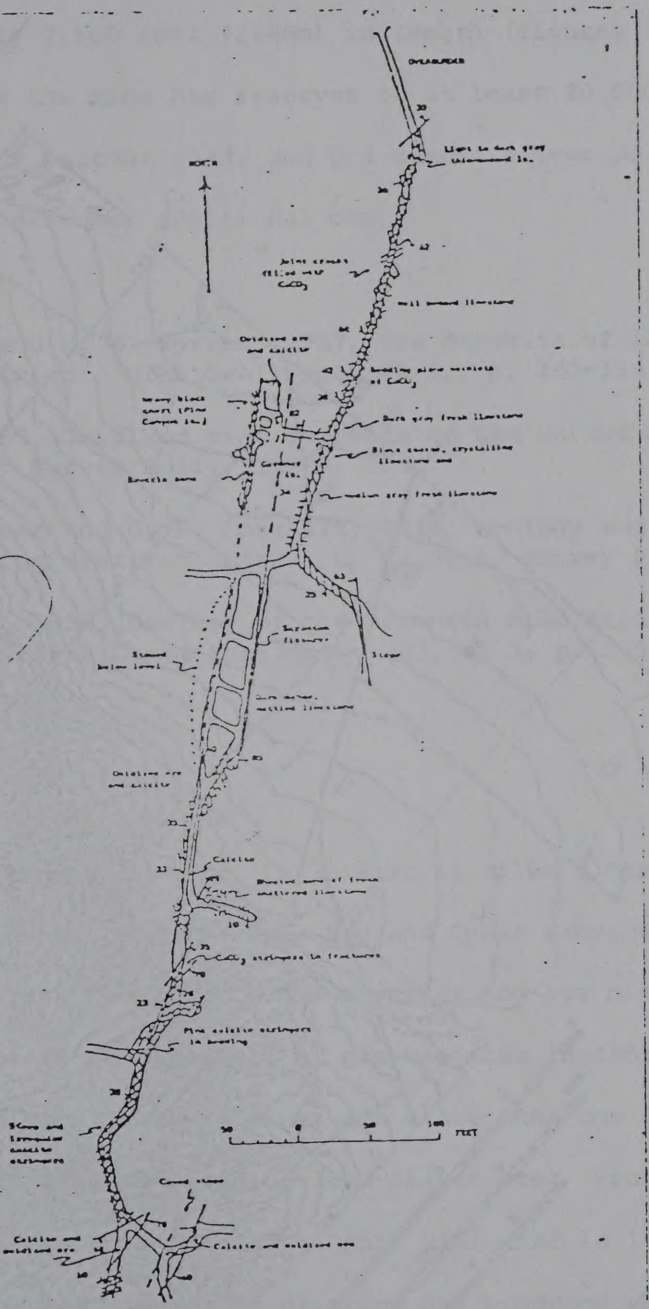


PLAN AND LONGITUDINAL PROFILE OF ORE BODIES IN SCRANTON MINES.

Adapted from Lingren and Loughlin, p. 271

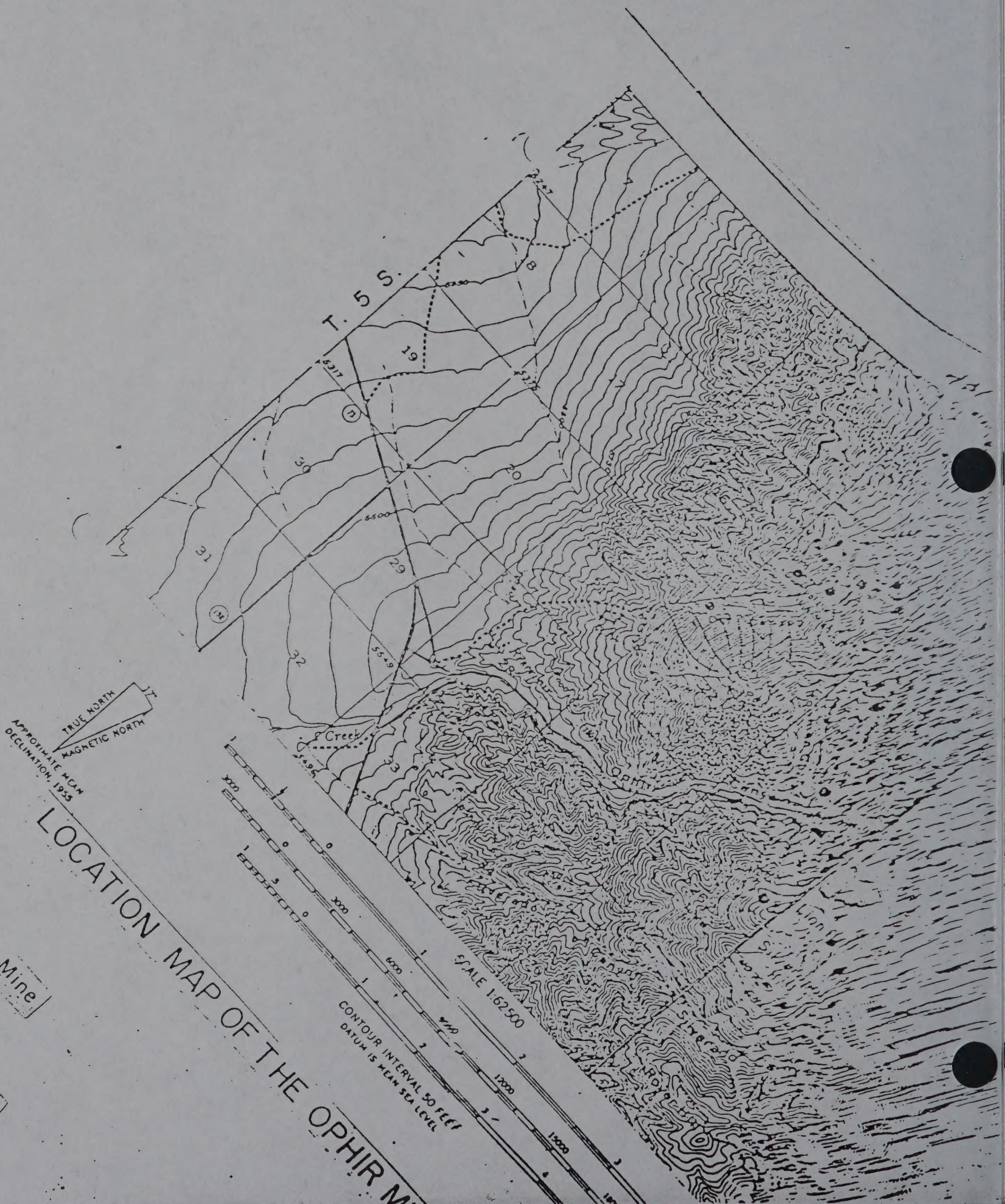
Figure 168:

GEOLOGIC MAP OF THE MAGAZINE WORKINGS


OVERBURDEN
NORTH
Light to dark gray laminated ls.
Joint cracks filled with CaCO3
Well banded limestone
Oxidized ore and calcite
Bedding plane veinlets of CaCO3
Heavy black chert (Pine Canyon ls.)
Dark gray fresh limestone
Breccia zone
Medium gray fresh limestone
Stoped below level
Stope
Oxidized ore and calcite
Calcite
CaCO3 stringers in fractures
Fine calcite stringers in bedding
Caved stope
Calcite and oxidized ore
Calcite and oxidized ore
50 0 50 100 FEET

Mine Map of the Magazine Workings of the Scranton Mine (South of the Shaft).

Adapted from Renzetti, p. 189



LOCATION MAP OF THE OPHIR M

cerussite, smithsonite, and hemimorphite; sulfide mineralization has been encountered in the lower workings of the mine. The mineralized zone in the mine is 3,000 feet (914m) long, 400 feet (122m) wide and 600 feet (183m) deep. Mine workings consist of a shaft and several adits. Total workings are approximately 7,500 feet (2286m) in length (figures 167 and 168). The authors estimate the mine has reserves of at least 20,000 tons averaging 4 percent zinc, 2 percent lead, and 0.1 ounces silver per ton. Exploration in the area may discover additional ore.

References:

Disbrow, A. E. and H. T. Morris, 1957, Ore deposits of the North Tintic mining district: Utah Geol. Soc. GB 12, p. 140-154.

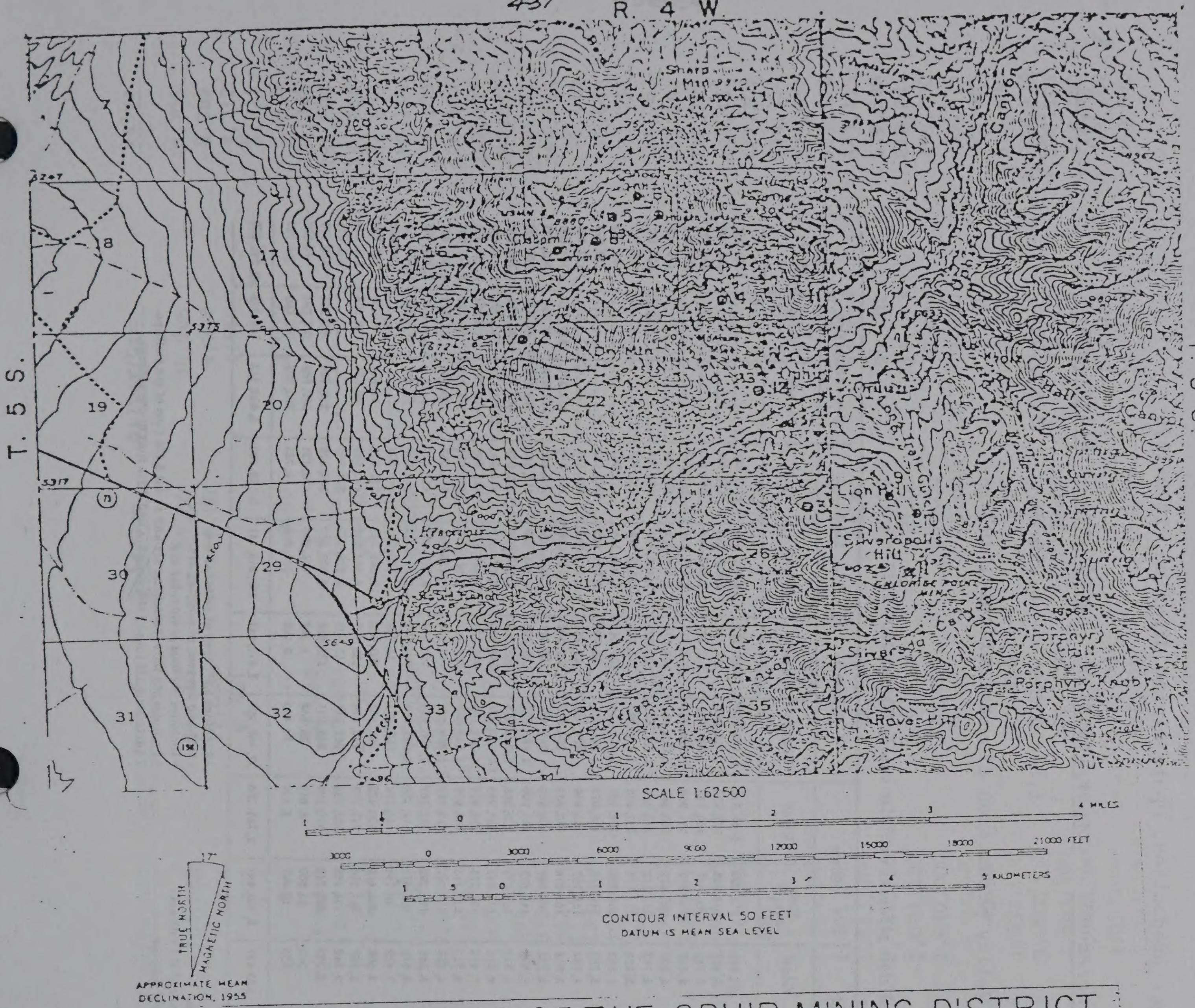
Heyl, A. V., 1963, Oxidized zinc deposits of the United States, pt. 2, Utah: U. S. Geol. Survey Bull. 1135-B, 104p.

Lindgren, Waldemar and G. F. Loughlin, 1919, Geology and ore deposits of the Tintic mining district, Utah: U. S. Geol. Survey Prof. Paper 107, 282p.

Renzetti, B. L., 1956, Geology of the Scranton mine area, Tooele County, Utah: Compass of Sigma Gamma Epsilon, v. 33, n. 3, p. 175-193.

Ophir District

The Ophir mining district is located 11 miles (18km) south of Tooele at the town of Ophir, encompassing Dry and Ophir Canyons on the southwestern side of the Oquirrh Mountains. The district and its mines are located on figure 169. The first discovery of ore was made in 1865 on the St. Louis lode, now the Hidden Treasure mine, and since then the district has produced many millions of dollars worth of lead-silver ore. Production was continuous from 1870 until the closing of the Ophir Hill mine in 1972; the district has been idle since that time. The district has produced about 356,424,846 pounds of lead and 88,241,753 pounds of zinc valued at $25,784,404 and $9,021,462 respectively along with significant amounts of copper, silver, and gold. Production figures are tabulated in table 44.



LOCATION MAP OF THE OPHIR MINING DISTRICT

1. Hidden Treasure Mine
2. Unknown Mine
3. Lion, Zella, Douglas Mines
4. Cliff Mine
5. Mono Mine
6. Kearsarge Mine
7. Queen of the Hills Mine
8. Wandering Jew Mine
9. East Side and other Mines
10. Buffalo Mine
11. Chloride Point Mine
12. Ophir Mine

Figure 169:

Table 44: Lead-zinc-copper-gold-silver production, Ophir mining district, 1870-1976

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1870-1900[1]	?	61,746,593	---	1,866,775	6,056.84	5,509,725	$7,958,358

[1] Calculated from combined Ophir-Rush Valley production figures (Gilluly, 1932)

Metals produced in Ophir mining district, 1901–1927

Year	Ore (short tons)	Gold		Silver		Copper		Lead		Recoverable zinc		Total value
		Fine ounces	Value	Fine ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
1901	[a] 29,600	192.97	$3,989	312,292	$187,373	1,109,476	$200,312	4,357,818	$187,388	----------	----------	$579,062
1902	24,115	164.33	3,397	252,326	133,733	913,622	111,462	3,358,535	137,706	----------	----------	386,298
1903	36,096	182.28	3,768	260,627	140,739	908 201	132,382	2,557.142	107,400	----------	----------	384,289
1904	[b] 37,571	186.02	3,846	240,847	137,908	1,018,577	127,322	2,461,937	107,710	----------	----------	376,786
1905	[b] 39,172	208.00	4,300	265,531	160,381	1,092,784	170,474	3,306,794	164,454	----------	----------	499,609
1906	[b] 40,848	249.00	5,147	257,175	172,307	1,566,831	302,398	7,408,228	422,269	----------	----------	902,121
1907	[b] 50,241	395.20	8,169	335,376	221,348	730,203	147,841	5,918,148	313,397	----------	----------	690,755
1908	[b] 53,002	221.64	4,582	328,606	174,161	1,053,359	139,043	6,000,168	252,007	----------	----------	569,793
1909	[b] 48,354	279.73	5,782	242,340	126,017	736,518	95,747	6,041,455	255,483	----------	----------	483,029
1910	[b] 18,268	230.57	4,767	158,257	85,459	297.253	37,751	6,943,846	305,529	----------	----------	433,506
1911	15.666	242.57	5,014	163,278	86,537	276,640	34,580	4,436,566	199,646	333,876	$19,031	344,808
1912	54,523	276.97	5,725	269,887	165,980	745,525	123,011	6,279,109	282,560	373,870	25,797	603,073
1913	[b] 74,761	236.96	4,898	448,673	270,909	1,462,552	226,895	9,435,529	415,163	769,143	43,072	960,937
1914	76,114	281.14	5,812	432,673	239,268	1,255,335	166,900	8,819,935	343,978	662,785	33,802	789,820
1915	91,572	337.58	6 978	637,643	323,285	2,212,377	387,166	12,232.549	574.930	1.099,138	136,293	1,428,652
1916	94,453	359.99	7,442	724,275	476,573	2,702,165	664,733	12,862,347	887,502	640,251	85.794	2,122,044
1917	80,044	277.92	5,745	538,745	443.926	2,233,687	609,797	9,581,712	824,027	573,528	58,500	1,941.995
1918	[c] 73,444	207.45	4,288	512,702	512,702	1,669,363	412,333	9,135.999	648,656	38,586	3,512	1,581,491
1919	[d] 66,567	260.66	5,388	412,292	461.767	1,290,464	240,026	8,387,451	444,535	----------	----------	1,151,716
1920	[e] 61,119	224.86	4,648	360,077	414,284	1.095,282	201,532	7,637,362	610,989	52,794	4.276	1,235,729
1921	[f] 4,061	69.57	1,438	40,194	40,194	90,895	11,726	900,050	43,202	----------	----------	96,560
1922	[g] 55,218	125.59	2,596	320,470	320,470	767,426	103,602	5,841,343	321,274	17,684	1,008	748,950
1923	[h] 60,585	140.15	2,897	387,528	317,773	943,476	138,691	6,886,989	482,089	96,965	6,594	948,044
1924	[i] 52,998	142.52	2,946	154,755	103,686	387,842	50,807	2,828,812	226,305	----------	----------	383,744
1925	[j] 40,358	305.85	6,322	302,742	210,103	886,271	125,851	5,890,562	512,479	212,159	16,124	870,879
1926	1,437	25.06	518	13,802	8,612	38.553	5,397	434,006	34,721	369,664	27,725	76,973
1927	1,271	26.84	555	10,791	6,119	24,440	3,202	314,019	19,783	392,023	25,090	54,749
	1,292,356	5,851.42	120,957	8,403,944	5,941,706	27,666,207	4,970,841	160,313,411	9,125,180	5,632,466	486,618	20,645,302

[a] Partly estimated

[b] Includes some lead and copper-lead concentrate.

[c] Includes 25,765 tons of shipping ore and 3,921 tons of old tailings.

[d] Includes 21,362 tons of shipping ore and some old tailings.

[e] Includes 17,322 tons of shipping ore.

[f] Includes 1,571 tons of shipping ore.

[g] Includes 500 tons of shipping ore.

[h] Includes 769 tons of shipping ore.

[i] Includes 502 tons of shipping ore and about 8,000 tons of old tailings.

[j] Includes 1,433 tons of shipping ore and 6,351 tons of old tailings.

Table 44 continued:

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1928	2,220	202,328	104,062	23,078	57.00	30,986	$40,705
1929	287	50,318	---	12,659	19.00	5,998	8,982
1930	107	36,180	---	6,431	15.00	4,566	4,712
1931	133	?	?	?	?	?	2,271
1932	21	4,327	---	---	3.00	1,023	475
1933	886	173,590	64,169	29,098	11.00	11,816	15,345
1934	11,411	2,698,811	1,839,116	310,400	133.65	119,343	285,592
1935	19,729	4,784,700	4,334,818	535,807	203.40	155,527	545,496
1936	26,314	7,723,283	7,125,180	814,663	220.00	194,643	944,930
1937	35,520	6,613,000	8,046,000	782,000	323.00	208,247	1,180,163
1938	21,242	4,025,543	3,786,812	874,102	140.00	144,919	551,189
1939	243,506	12,099,553	2,536,692	4,139,971	420.00	781,471	1,676,297
1940	164,931	10,708,340	1,206,413	2,189,398	329.00	585,983	1,287,037
1941	18,315	2,874,000	345,600	408,500	201.00	158,009	357,338
1942	11,245	3,245,600	378,300	403,200	90.00	134,602	400,291
1943	12,185	2,921,400	254,500	231,400	129.00	146,627	385,456
1944	6,095	729,600	157,500	128,000	100.00	53,460	135,119
1945	1,703	230,500	108,600	27,000	16.00	12,870	45,669
1946	3,734	671,000	588,500	56,000	27.00	22,380	173,036
1947	8,904	1,580,000	1,974,100	222,100	100.00	90,095	598,063
1948	7,702	1,582,300	1,572,600	234,200	113.00	71,838	612,182
1949	10,866	2,195,700	2,007,500	250,500	158.00	96,746	738,289
1950	7,900	1,896,000	748,300	92,800	103.00	65,561	444,462
1951	11,395	1,423,200	682,300	80,300	81.00	54,914	442,361
1952	20,746	1,997,600	1,339,500	125,500	82.00	74,186	644,354
1953	19,185	2,313,200	1,383,100	116,700	75.00	87,773	577,682
1954	19,237	2,317,800	1,505,900	150,700	74.00	88,721	607,520
1955	17,768	2,254,100	1,512,000	142,300	66.00	72,803	643,115
1956	15,421	1,924,300	1,341,800	212,900	120.00	109,281	679,530
1957	18,426	2,836,000	2,084,100	209,500	110.00	114,813	818,241
1958	11,570	1,780,000	1,640,000	170,000	100.00	70,000	489,000
1959	1,000	108,000	60,000	38,000	49.00	2,000	34,875
1960	?	75,000	48,900	7,100	5.00	3,538	20,953
1961	?	2,345,400	1,531,600	229,500	99.00	109,372	613,630
1962	?	4,772,900	3,283,300	507,000	132.00	223,536	1,236,494
1963	?	5,068,000	3,565,500	479,600	139.00	243,903	1,390,101
1964	?	4,522,900	2,944,600	422,700	118.00	219,797	1,419,080
1965	?	4,299,500	3,057,800	344,200	110.00	194,482	1,469,282
1966	?	6,034,100	4,087,200	526,300	157.00	268,924	2,060,070

Table 44 continued:

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1967	?	6,817,400	4,218,400	350,800	149.00	234,200	$1,980,965
1968	?	4,925,500	3,100,800	242,800	102.00	156,485	1,566,847
1969	?	4,198,000	2,749,600	258,100	89.00	156,456	1,425,691
1970	?	2,526,300	1,650,900	254,800	70.00	124,026	1,021,603
1971	?	4,602,915	3,462,472	430,937	200.00	192,057	1,709,221
1972	?	176,654	130,753	25,903	---	9,291	212,909
1973-1976				no production			
Totals:	2,039,060+ (incomplete)	356,424,846	88,241,753	46,629,929	16,623.31	19,820,937	$60,100,283

1870-1900: Calculated from combined Ophir-Rush Valley production figures (Gilluly, 1932)
1901-1927: From Gilluly, 1932
1928-1957: U. S. Bur. Mines Mineral Yearbooks
1958-1959: Rough estimate
1960-1972: Stowe, 1975, table 27.

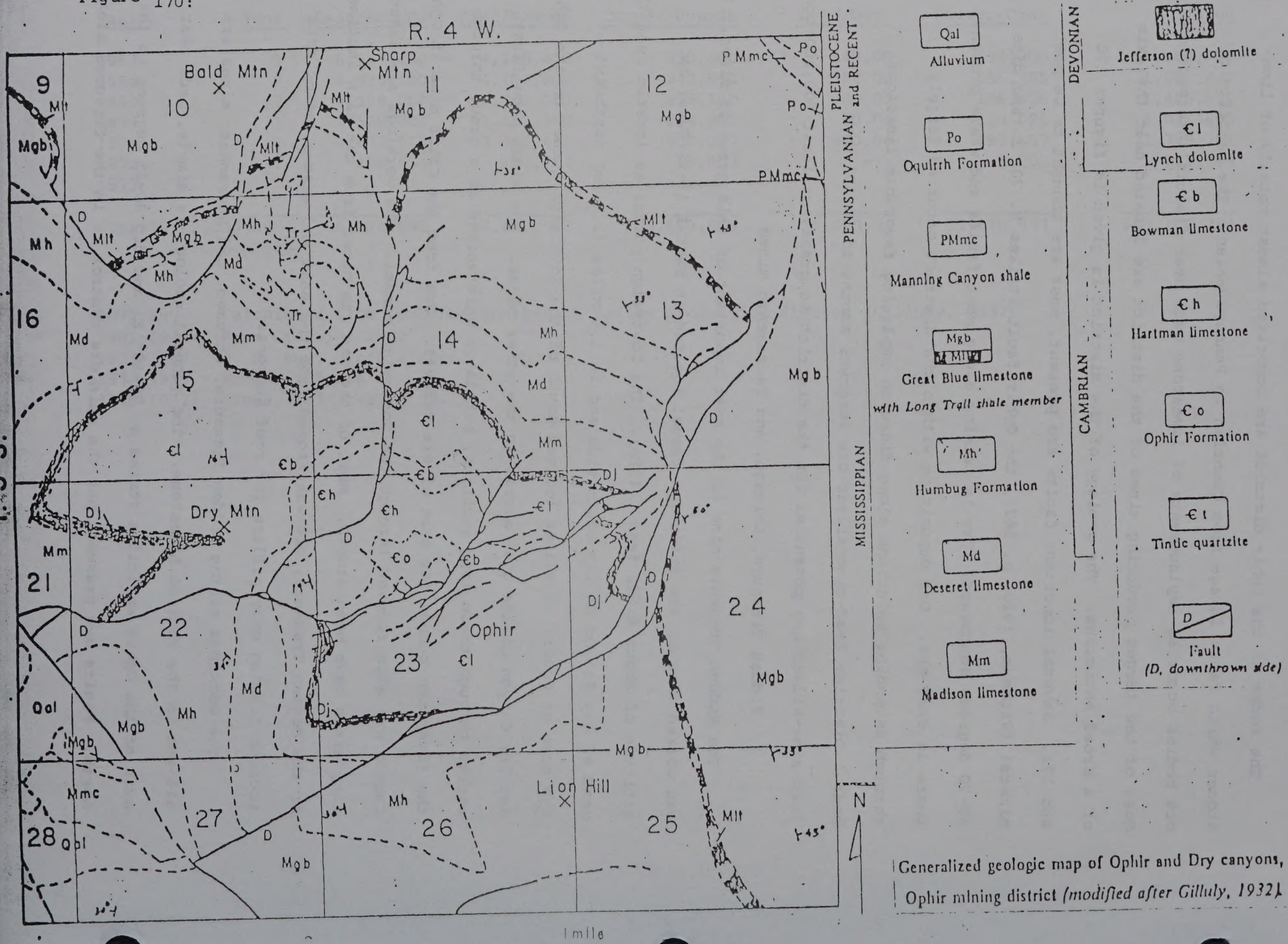
The rocks of the Ophir district are comprised almost totally of limestones which range in age from Cambrian to Pennsylvanian. The majority of ore bodies occur as replacements of limestone beds near fissure intersections. Most of the larger producing mines of the district are located near the axis of a broad anticline. The geology of the district is given in figures 170 and 171. Several important faults are present, most are thought to be post-mineral (Wichman, 1920, p. 562), the Ophir fault strikes N. 70° E. and dips 60-70 degrees southward. Ore is lacking along most faults and where present, there is drag ore. Ore deposition within the district occurred largely through ascending solutions along fissures replacing favorable limestone beds. District lead-zinc-silver ore reserves amount to 50,000 tons. The lead-zinc-silver ore potential for the district is great, at least 500,000 tons.

Hidden Treasure, Chicago, and Sacramento Mines

The Hidden Treasure mine is the most important of this group of mines. It was worked through the Sovereign tunnel located in SWNENE 15-5S-4W at an altitude of about 8,000 feet (2438m). The Sovereign portal is located near the head of Dry Canyon on its south side and is 1.5 miles (2.4 km) northwest of the town of Ophir. Inclines located south of the Sovereign tunnel on the Ophir and Dry Canyon divide give access to the other mines. The mines were first worked through these long inclines, but later were worked as a group through the Sovereign tunnel for ease of ore removal. Ore from the Cliff mine in Ophir Canyon was also removed through the Sovereign tunnel. The workings are extensive, many areas have been stoped. Most of the ore was mined from the main incline of the Hidden Treasure, ore was stoped from the east and west sides of this incline leaving only pillars for roof support.

The workings of the Hidden Treasure, Chicago, and Sacramento mines are all cut in the Madison Limestone. The general geology is simple, beds near the axis of the Ophir anticline strike N. 70-80° E. and dip 30-35 degrees to the north. Faults are present, but the main ore control is in the fissures along

Figure 170:



Generalized geologic map of Ophir and Dry canyons, Ophir mining district *(modified after Gilluly, 1932).*

Figure 171:

SEDIMENTARY ROCKS OF THE STOCKTON AND FAIRFIELD QUADRANGLES, UTAH

Age	Formation	Thickness (feet)	Lithology and remarks
Quaternary (Recent and Pleistocene).	Alluvial and lacustrine deposits, including Lake Bonneville beds (of Wisconsin and probably pre-Wisconsin age).	1,000+	Unconsolidated or only partly consolidated gravel, sand, and silt, overlain in the lower areas by lake silt and gravel beaches of Lake Bonneville. Some glacial fill of probable Wisconsin age in the high mountains. Some fanglomerate and stream gravel of post-Lake Bonneville age.
Unconformity— Tertiary (Miocene or Oligocene). Unconformity—		200+	Fine conglomerate and coarse grit, unfossiliferous.
Pennsylvanian.	Oquirrh formation.	15,000+	Interbedded lenticular quartzite and limestone, becoming more quartzitic toward the top. With very subordinate thin beds of shale and dolomite. Top not exposed in this area.
Unconformity?—	Manning Canyon shale.	1,140±	Dominantly shale with some thin beds of limestone and, in the lower half, 2 fairly persistent quartzite beds. The portion above the upper quartzite is Pennsylvanian; the portion below it, upper Mississippian.
Upper Mississippian.	"Great Blue" limestone.	3,600	Light-blue limestone, with thin partings of reddish-weathering shale and with an 85-foot bed of black carbonaceous shale, the Long Trail shale member, about 500 feet above the base.
	Humbug formation.	650	Interbedded limestone and lenticular sandstone and quartzite in beds as much as 100 feet thick but ordinarily from 2 to 10 feet thick.
	Deseret limestone.	650	Blue-gray cherty limestone in beds averaging about 2 feet thick, with a 6 to 8 foot bed of phosphatic shale at the base.
Lower Mississippian.	Madison limestone.	460	Highly fossiliferous blue-gray limestone, rather thin bedded at the base, more massive and cherty toward the top.
Unconformity— Middle (?) Devonian. Unconformity—	Jefferson (?) dolomite.	185	Coarsely crystalline gray dolomite, weathering dark gray; one massive bed containing conspicuous white calcite fossil casts.
Upper Cambrian.	Lynch dolomite.	825–1,000	Thick-bedded light-gray dolomite, with some dark-gray dolomite spangled with short white rods in the lower part and with a few limestone beds, especially in the lower half.
----------(?)---------- Middle Cambrian.	Bowman limestone.	280	Mottled shaly limestones, intraformational conglomerate and oolitic limestone, with a shaly member about 3 feet thick at the base.
	Hartmann limestone.	650	Gray mottled limestone in thin beds with shaly parting some oolite toward the top.
	Ophir formation.	320	Micaceous shales, sandy toward the base, becoming les so upward and containing several beds of mottled sha limestone.
---------------------- Lower Cambrian.	Tintic quartzite.	300+	Thick-bedded cross-bedded white quartzite weatherin with a rusty surface. Becomes shaly toward the to and grades into the overlying Ophir formation.

Adapted from Guilluly, 1932, p. 7.

which the limestone beds are replaced. These fissures are nearly vertical and have a northward strike. The ore bodies are generally pipe-like as they follow the fissures. The ore from the Hidden Treasure group was largely a high grade lead-silver-zinc type with paying amounts of gold and copper. Most of the ore mined was found in large masses, in some places 100 feet (30.5m) high and as much as 50 feet (15.2m) wide (Gilluly, 1932, p. 144). The major ore minerals are galena and sphalerite. Additionally, cerussite, smithsonite, plumbojarosite, hydrozincite, azurite, malachite, aurichalcite, cuprite, chalcopyrite, and horn silver are reported by Gilluly. The gangue minerals are quartz and calcite with lesser amounts of epidote, diopside, chlorite, wollastonite, chert, tremolite, adularia, and andradite. The ore grade was very high and was sent directly to the smelter. The average grade before World War I was reported to be about 13-15 percent lead, less than 1 percent copper, and about $0.25 gold to the ton. The zinc grade was not recorded. Samples of ore from the mine were assayed and results are shown in table 45. An ore reserve of 25,000 tons remains as room pillars and there is an additional potential of 100,000-200,000 tons of lead-silver-zinc ore remaining in the mines area.

Mono Mine

The Mono mine is located on the north side of Dry Canyon, a short distance below the head of the canyon, near creek level. It is accessible by a rough dirt road within Dry Canyon or by the long road from Stockton which winds around the side of the mountain into Dry Canyon. The mine entrance is 1250 feet (381m) southwest of the Sovereign tunnel of the Hidden Treasure mine and about 1/2 mile (0.8 km) from Gisborn. The mine is located in SESENW 15-5S-4W at an elevation of 8,540 feet (2576m). The mine has produced over $1,000,000 worth of ore. The mineralization was discovered in 1871 and the principal production occurred in the succeeding four years. Production since that time has been sporadic (Gilluly, 1932, p. 154). The mine was first developed by means of an incline and later by a lower tunnel. **The workings include a large amount of drifting,** crosscutting and stoping, the lengths of which amount to several thousands of feet. There are a few raises and winzes that followed ore (figure 172).

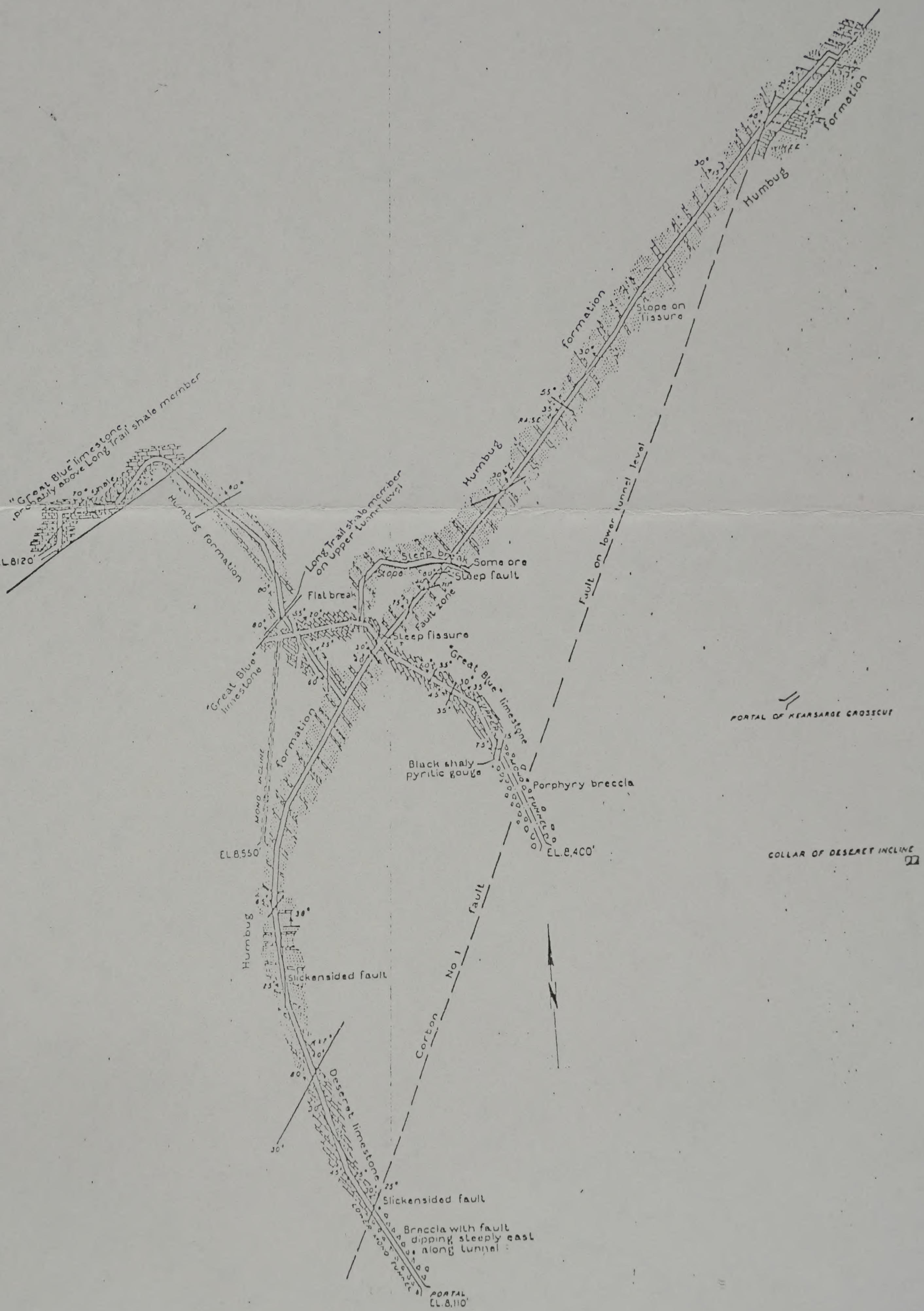
The workings of the mine are within the Deseret Limestone, Humbug Formation and Great Blue Limestone of Upper Mississippian age. The mine workings are located on the eastern flank of the Ophir anticline. There are some faults and fissures within the mine and ore occurs in replacement beds near the fissure intersections. Ore bodies are tabular and as much as 30 feet (9m) wide, varying from 4-5 feet (1.2-1.5m) in thickness. The ore bodies follow a general strike of N. 50° E. with a 30 degree northeasterly dip. The ore minerals found include galena, cerussite, sphalerite, chalcopyrite, horn silver, malachite, azurite, and plumbojarosite. Gangue minerals are limonite, hematite, jarosite, pyrite, quartz and calcite. The ore potential in this area is unknown.

Wandering Jew Mine

The Wandering Jew mine is located on the north side of Dry Canyon, the portal is about 1950 feet (594m) southwest of the Hidden Treasure mine and 850 feet south-southwest of the Mono portal. The mine is located in SWSWNE 15 5S-4W at an elevation of 8,025 feet (2446m) and is accessible by two dirt roads, one up Dry Canyon and one from Stockton that angles into the canyon from the mountain side. The mine was developed late in the history of the district, but was worked extensively and has a production value in excess of a million dollars. Entrance to the mine is by means of an inclined shaft following ore-containing fissures. The workings consist of raises, winzes, drifts, and crosscuts with some inclined stopes along the replaced beds. The length of workings is in excess of 5,000 feet (1524m).

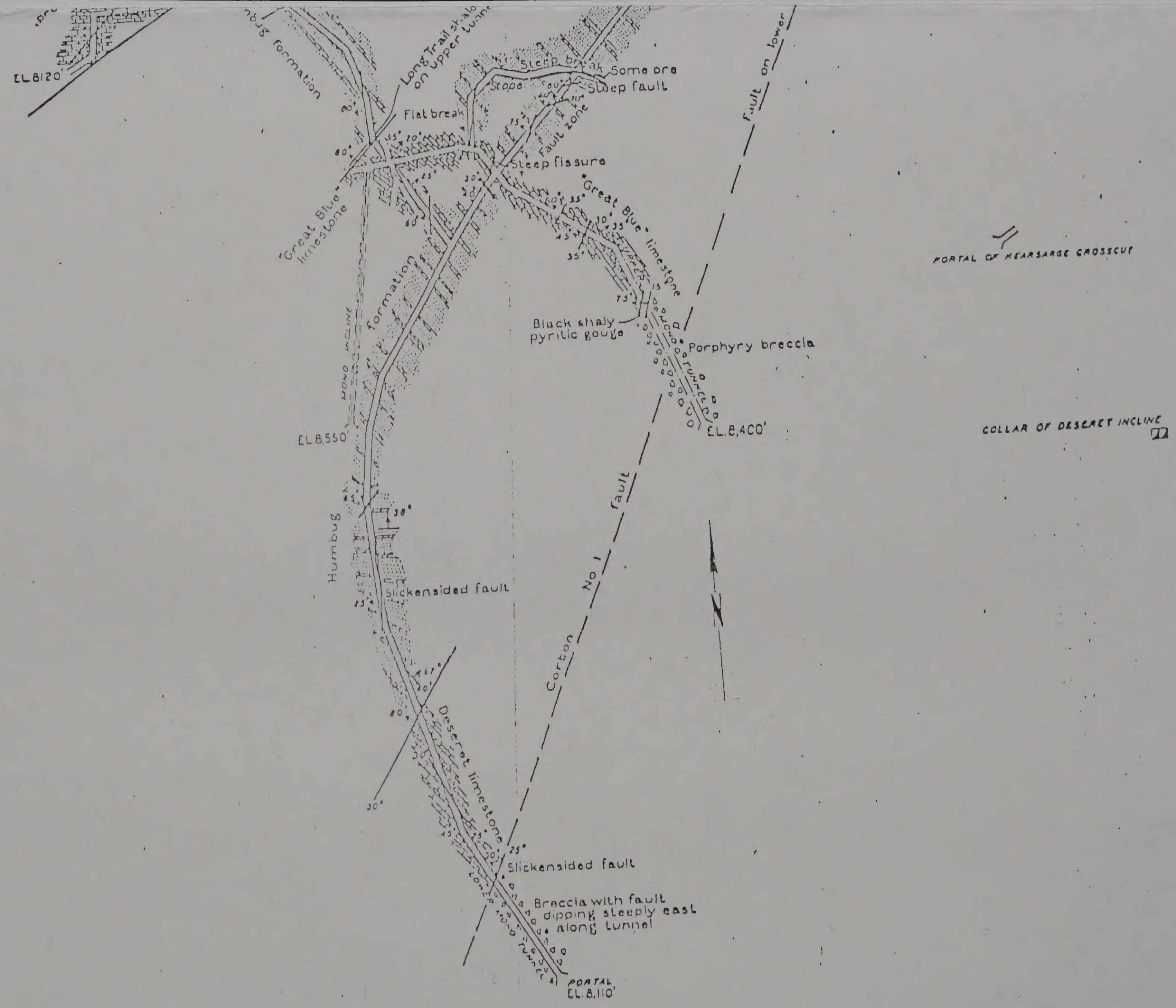
The high grade lead-silver ore tended to follow the bedding which strikes N. 80° E. and dips 30 degrees, north. The mine workings are on the eastern side of the Ophir anticline within the Deseret Limestone. Samples taken in the mine and their assays are shown in table 45. The ore minerals are galena, cerussite, sphalerite, malachite, and azurite in a gangue of limonite, calcite, and quartz.

Figure 172: PLAN MAP OF THE MONO MINE



MONO MINE

Adapted from Guilluly, 1932, plate 29



MONO MINE

Adapted from Gullluly, 1932, plate 29

The potential ore reserve for this property is several thousand tons.

Kearsage Mine

The Kearsage mine is located near the head of Dry Canyon, about 900 feet (274m) north-northwest of the Sovereign tunnel and about 1,600 feet (488m) northeast of the lower Mono tunnel. The mine is situated on the west slope of Shoofly Hill in SWNESW 15-5S-4W at an elevation of 8,400 feet (2560m) above sea level. The mine was located in 1871 and produced well over a million dollars worth of ore in less than ten years after it was opened. The mine was worked sporadically thereafter. The mine workings, stopes, a few raises, crosscuts and drifts, are not very extensive considering the large production (figure 173). The mine workings are accessible by an inclined shaft located near the crest of Shoofly Hill near an adit on the western slope below the upper incline. The total length of workings is a few thousand feet (1000m).

The mine is located on the east side of the Ophir anticline and the host rock is the Upper Mississippian Humbug Formation. Ore occurs in replacement beds and as fissure fillings in limestones and quartzites. The general strike of the ore bodies is N. 45° E. and the dip is steep. High-grade silver ore contained smaller amounts of lead, gold, copper, and zinc. The ore was of such high value that it was reported to have had assays of $10,000 in silver per ton. Most of the ore was oxidized containing residual sulfides. The ore minerals are plumbojarosite, smithsonite, azurite, malachite, and galena in a gangue of jarosite, limonite, and calcite.

Unknown Mine

This mine, name unknown, is located on the north wall of Dry Canyon near its mouth in NWNWNW 22-5S-4W at an approximate elevation of 7,000 feet (2134m). The workings are dry and in excellent condition. Raises, drifts, and crosscuts were noted and total workings aggregate a little over 1,000 feet (305m). Ore appears to replacements in favorable Madison Limestone beds. The mine is located on the western flank of the Ophir anticline. Ore minerals are sphalerite, galena,

Table 45: Assays from the Hidden Treasure and Wandering Jew mines, Ophir district.

Sample No.	Lead	Zinc	Gold	Silver	Copper
1.	3.93%	2.50%	0.033 oz/ton	2.57 oz/ton	1.11%
2.	0.95	0.89	0.011	1.29	0.15
3.	2.92	1.10	0.010	1.55	0.25
4.	54.10	10.50	<0.001	1.23	2.13
5.	9.36	14.30	0.002	6.04	0.26
6.	0.12	2.50	0.850	0.09	0.13
7.	37.90	0.04	0.003	10.80	0.29

Sample Locations

1. Random cut from a stope in the lower west side incline of the Chicago incline, Hidden Treasure mine.

2. Grab sample of hematitic material stock-piled on the dump of the Sovereign tunnel, Hidden Treasure mine.

3. Grab sample of hematitic material stock-piled on the dump of the Sovereign tunnel, Hidden Treasure mine.

4. High-grade galena-pyrite-chalcopyrite sample from the main interior incline near level 2, Hidden Treasure mine.

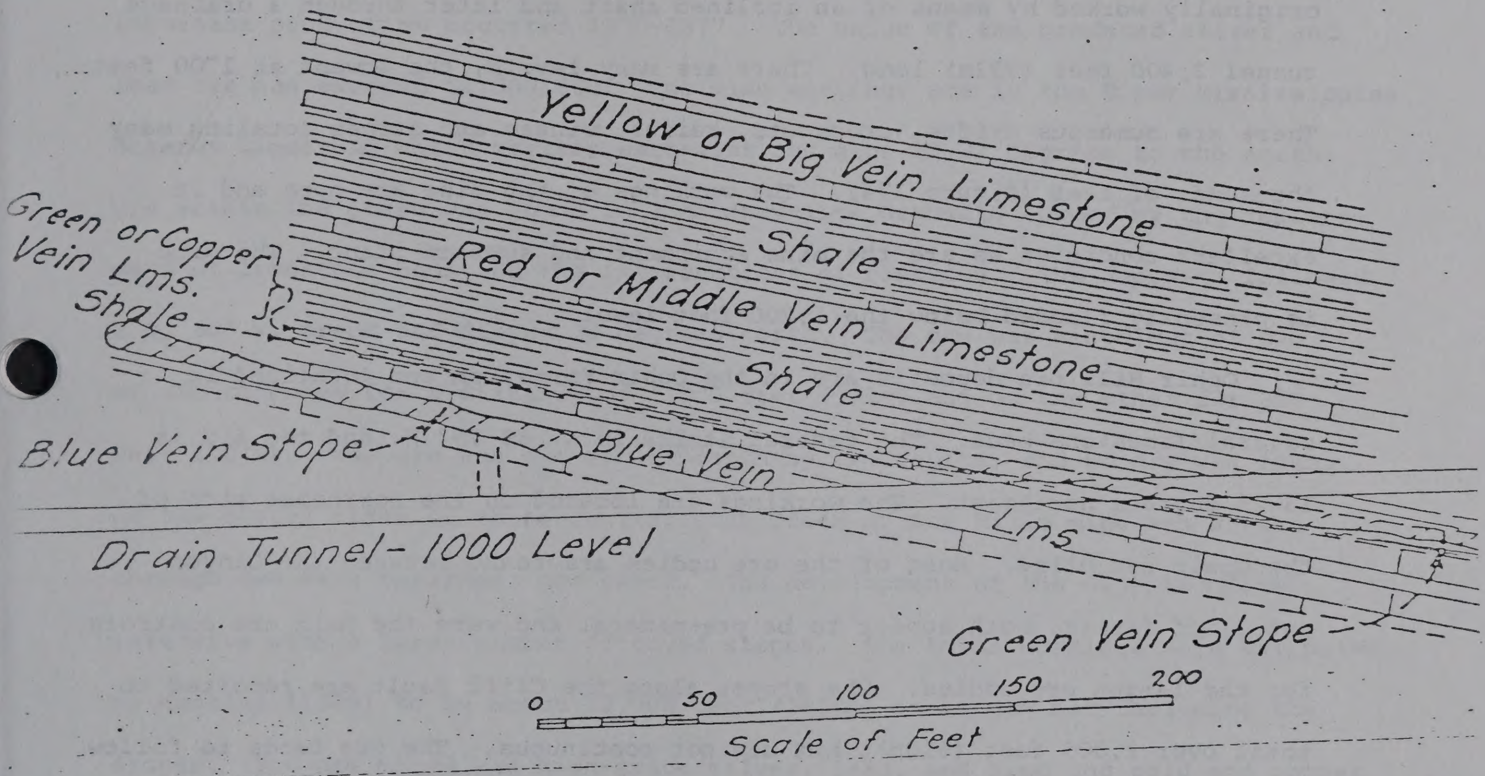
5. Six-inch (15cm) cut across a vein to the west of the interior shaft station, Hidden Treasure mine

6. Two-inch (5.1 cm) cut of ore from a drift about 500 feet (152m) down the main incline on the east side, Wandering Jew mine.

7. High grade galena sample taken near the location for sample 6, Wandering Jew mine.

Figure 174:

SECTION THROUGH NORTHWESTERN WORKINGS OPHIR HILL CONSOLIDATED MINE


Yellow or Big Vein Limestone
Shale
Green or Copper Vein Lms.
Red or Middle Vein Limestone
Shale
Shale
Blue Vein Stope
Blue Vein
Drain Tunnel - 1000 Level
Lms
Green Vein Stope
0
50
100
150
200
Scale of Feet

Adapted from Wideman, 1947, figure 4

at an elevation of 6,620 feet (2018m). Mineralization was discovered in 1864 and major production began in 1870. The Ophir Hill mine has been one of the large producers of the district, it produced 30 thousand tons of ore per year for 20 years before production stopped in 1972. The closing of Anaconda's Tooele smelter eliminated the market for lead-zinc in the area and the Ophir Hill was forced to close with ore blocked out. At the time of closing, the mine was operated under a lease by McFarland and Hullinger of Tooele, Utah, the property is owned by U. V. Industries of Salt Lake City. The mine was originally worked by means of an inclined shaft and later through a drainage tunnel 2,400 feet (732m) long. There are many levels, the lowest at 1700 feet. There are numerous drifts, crosscuts, raises, winzes and stopes totaling many thousands of feet (figure 174). The workings of the mine are open and in excellent condition as are the mine equipment and surface plant. The mine is presently flooded below the 1,200-foot level.

Ophir Hill ore deposits are in the Ophir Formation and localized in several limestone beds. The general strike is N. 60-75° W. and the dip is 15-25 degrees northeast. The workings are located on the northeast side of the Ophir anticline. Most of the ore bodies are found between the Canyon and Cliff faults, both appear to be pre-mineral and were the main ore controls for the larger ore bodies. The stopes along the Cliff fault are reported to total over 2,000 feet (610m), but are not continuous. The ore tends to follow vertical fissure systems replacing limestone beds. Lead-silver-zinc ore was mined from the Ophir Hill mine along with smaller amounts of copper and manganese. The ore grade was not very high, but remained fairly constant; about 5-6 percent lead, 4-8 percent zinc, and 6-7 ounces silver to the ton. The ore minerals are galena, sphalerite, chalcopyrite, argentite, tennantite, pyrrhotite, pyrolusite, psilomelane and wad. The gangue minerals are pyrite, quartz and calcite. A measured 25,000 ton ore reserve remains in the mine reportedly with a grade of 7 percent lead, 7 percent zinc, 1 percent copper and about 5 ounces silver per plumbojarosite and cerussite. Gangue minerals are limonite and calcite. There is no information available of the mine's production and there is little potential for an ore reserve.

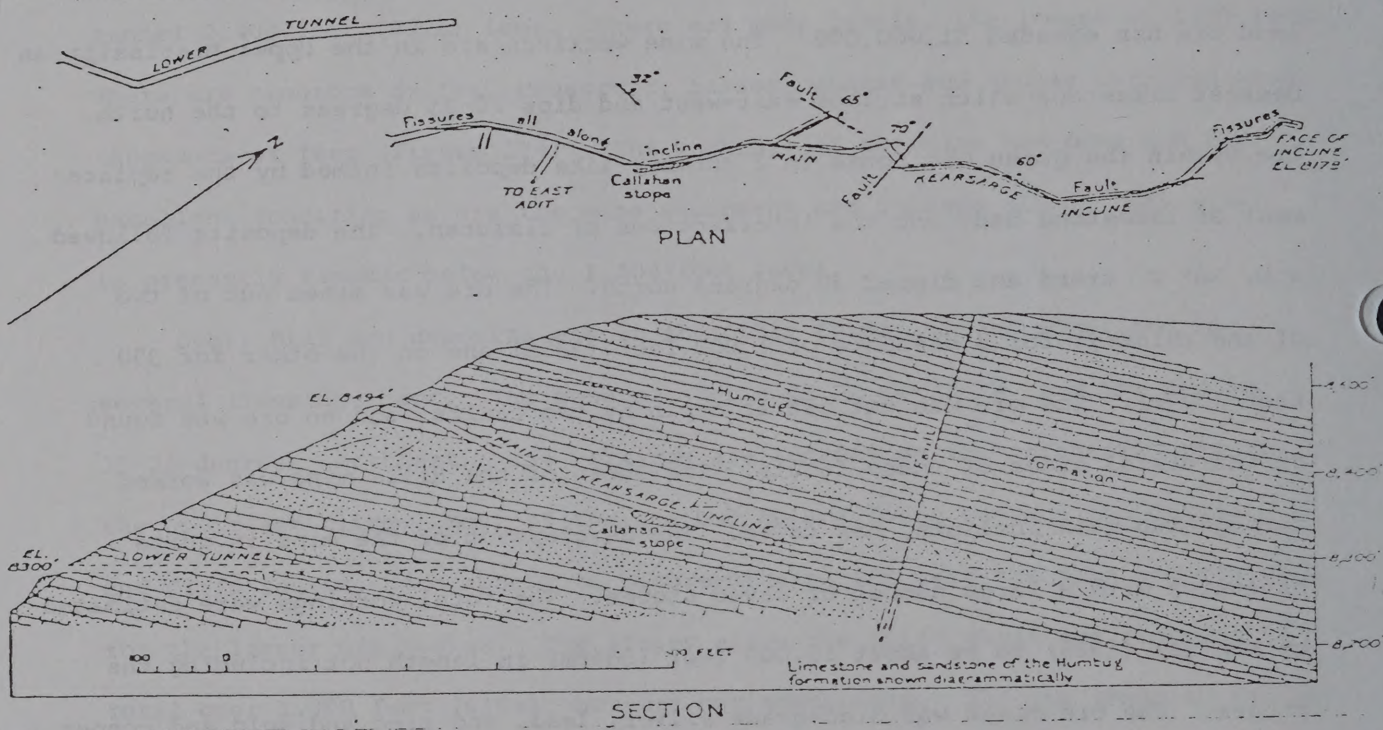
Queen of the Hills Mine

The Queen of the Hills mine is located on the north side of Dry Canyon 1/2 mile (0.8 km) west-southwest of the Mono mine above the road level that leads into Dry Canyon from Stockton in SWSENW 15-5S-4W at an approximate elevation of 8,500 feet (2591m). The property was located in 1870 and most of the important production occurred 1870-1877. The value of the produced silver and lead ore has exeeded $1,000,000. The mine workings are in the Upper Mississippian Deseret Limestone which strikes east-west and dips 20-25 degrees to the north. Ore within the Queen was found in 3 chimney-like deposits formed by the replacement of limestone beds and the intersections of fissures. The deposits followed a N. 30° W. trend and dipped 30 degrees north. The ore was mined out of two of the chimneys for a distance of 1,000 feet (305m) and on the other for 350 feet (107m). The ore was cut off at depth by two faults, and no ore was found on the distal sides of these faults. The Queen of the Hills mine was worked through two main inclines, now caved. The development of the mine is quite extensive with a large number of caved stopes. The total workings were estimated by Huntley (1885) to be about 12,000 feet (3658m) in length not including the stopes. The ore mined was high-grade silver, lead, and zinc and gold and copper were mined in paying amounts. Later year assays reported by Gilluly (1932) showed 19 percent zinc, 6 percent lead, 1.4 percent copper and 7 ounces of silver per ton. Assays of ore shipped in the earlier years were reportedly 30 to 40 ounces of silver per ton and 30-50 percent lead. The ore potential of the Queen of the Hills is small.

Ophir Hill Mine

This mine is located about 1/4 mile (0.4km) northwest of the town of Ophir, the dump is visible from the road upon entering the town, in NWSESE 23-5S-4W

Figure 173: PLAN MAP AND SECTION OF THE KEARSARGE MINE



Adapted from Guilluly, 1932, p. 153

ton. Exploration and development should easily increase the reserve of this mine.

Cliff Mine

The Cliff mine is located one mile (1.6 km) northwest of Ophir along the steep northern side of Ophir Canyon and is reached by a road with a series of steep switchbacks. The mine is in NWSESW 14-5S-4W and its adits are at elevations of 7,840, 8,060, and 8,260 feet (2390, 2457, 2518m). The mine has been worked intermittently since the early days of the district and has been one of the larger producers. Ore produced is valued at 2-3 million dollars. Ore was transported down the canyon by means of an aerial gravity tramway, a mile in length, and through the Sovereign tunnel in Dry Canyon. The mine is accessible through 3 adits which are 2,100, 1,450, and 800 feet (640, 442, 244m) in length. The workings follow the Cliff fault, numerous drifts, raises, and winzes extend from it. The middle level is connected with the Hidden Treasure mine in Dry Canyon, the mines were worked together since 1918.

The tabular ore deposits are found principally in the Madison Limestone, but are also found in the Lynch and Jefferson Dolomites along the Cliff fault. The primary commodities are lead and silver, copper,gold, and zinc are found in smaller quantities. Ore minerals include galena, sphalerite, smithsonite, plumbojarosite, cerussite, malachite, azurite, aurichalcite, chalcopyrite. The gangue minerals include diopside, andradite, epidote, tremolite and pyrite. The ore grade is reported to have averaged 13-15 percent lead, 8 ounces silver, less than 1 percent copper and small amounts of gold and zinc. The potential ore reserve of this mine is unknown.

Chloride Point Mine

This mine is located on the east flank of Silveropolis Hill, south of Lion Hill, and is reached along the Long Trail Gulch road, 1/2 mile (0.8km) east of Ophir. It is in SENESW 25-5S-4W at an elevation of 8,150 feet (2484m). The property was located in 1870 and was one of the first mines in the Lion

Hill area. Most of the ore was mined out in the early days. The value of the mine production is not exactly known, estimated to be in excess of a million dollars. The mine workings are caved, a large number of reworked dumps cover the hillside. The mine is developed by an adit, several crosscuts and drifts that follow fissures; total workings are reported to be about 5,000 feet (1524m) in length. The workings are in the Great Blue Limestone on the east side of the Ophir anticline, the beds strike N. 10° W. and dip about 30 degrees to the east. Several faults in the area served as ore controls. The ore bodies are either blanket or pipe-like deposits replacing limestone, some were large and stopes of 80 feet (24m) in width are reported. The ore is principally oxidized with cerussite, plumbojarosite, malachite, and cerargyrite. Gangue minerals include limonite, jarosite, calcite, and quartz. Small quantities of aurichalcite, bornite, stibnite, stibiconite and argentojarosite are reported. The high grade ore averaged 70 ounces of silver to the ton, 8 percent lead and a small amount of copper and gold. The ore potential of this mine is unknown.

Lion, Zella and Douglas Mines

This group of mines is located near the top of Lion Hill, 3/4 mile (1.2km) south of Ophir and is reached by dirt road up Long Trail Gulch. The mines are in NENENE 26-5S-4W at an elevation of 8,290 feet (2527m). These mines were worked during the early days of the district, little production was achieved thereafter. The mines are reported to have produced in excess of a million dollars worth of ore. The workings have been caved for many years and total about 6,500 feet (1981m) in length and include several shafts and tunnels. All the ore is found in replacement beds in the Great Blue Limestone on the western side of the Ophir anticline. The silver-lead ore was high in grade with reports that a 1000 tons contained 100 ounces of silver per ton. The ore potential for this group of mines is unknown, but probably small.

Buffalo Mine

The Buffalo mine is located near the top of Long Trail Gulch east of

Lion Hill. The portal is in NWSWNE 25-5S-4W at an elevation of 7,940 feet (2420 m). The mine was worked in the early days of the district and the total production is not known. Some information shows the value of ore production to be in excess of $150,000, but the total is probably higher. The mine was worked through two adits, both of which are now caved. The workings consist of adits, drifts and crosscuts. Large high-grade areas of ore were stoped and the total workings are reported to be in excess of 6,000 feet (1829m).

The Upper Mississippian Great Blue Limestone is the host rock and the mine is situated near the axis of the Ophir anticline on its south side. The beds strike N. 25° E. and dip 25 degrees to the southeast and mineralized fissures strike N. 70° E. to N. 65° W. The ore in the mine occurs both as tabular and pipe-like replacement bodies in limestone. Generally, ore follows fissures and it was reported that a shoot on the St. Clair fissure was solid galena 2 feet (0.6m) wide and 12 feet (3.7m) high. Most of the ore is of the sulfide type and there are only minor quantities of oxides in the upper workings. Ore in the early years carried 40-50 percent lead. Reportedly there was an ounce of silver to each percent of lead per ton. Small amounts of gold and copper were also reported. Ore minerals include galena, chalcopyrite, cerussite, plumbojarosite, cerargyrite, malachite, and wad. The gangue minerals are pyrite, jarosite, limonite, calcite, fluorite and quartz. The potential for additional ore is unknown.

East Side, Monarch, Iron, Empire, Northern Light, Woodruff Mines

This group of mines is located on the northeast and east sides of Lion Hill and is reached by dirt road up Long Trail Gulch, the portals are in SWNENW 25-5S-4W at an elevation of 8,160 feet (2487m). The mines were worked during the early days of the district and sporadically thereafter. The mines are now all caved and inaccessible. There are several thousand feet of workings including drifts, crosscuts, raises, and winzes. The geology is similar to that at the Chloride Point mine. The mines are cut in the Great Blue Limestone on the east side of the Ophir anticline. The ore tends to follow irregular fissures and is found as both pipe-like and tabular bodies. Most of the ore is in the form of oxides and is located fairly close to the surface. The ore minerals are cerussite, plumbojarosite, cerargyrite and wad. The gangue minerals are calcite and quartz. The ore grade of this mine was reported to be exceptionally high with as much as 6,000 ounces of silver and 3 ounces of gold per ton in the better shipments. Lead assays ran as high as 35 percent. The ore potential for this group is unknown.

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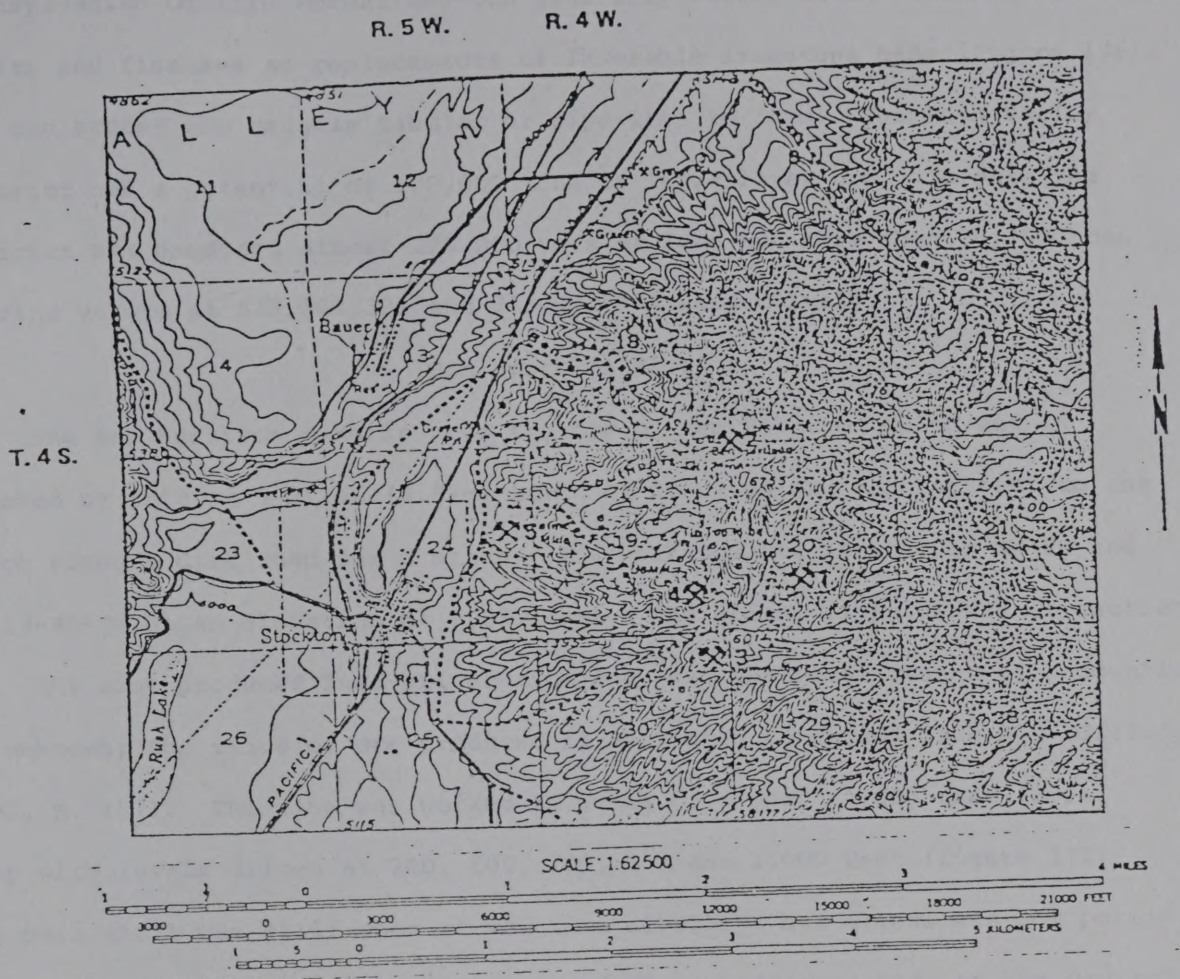
Wideman, F. L., 1947, The Ophir Hill Consolidated lead-zinc mine, Tooele Co., Utah: U. S. Bur. Mines Rept. Inv. 4072, 13p.

Rush Valley District

The Rush Valley mining district is located east of Stockton and 6 miles (10 km) south of Tooele, Utah. The mines of the district are spread over a large area on the western foothills of the Oquirrh Mountains (figure 175). The first discovery was made in April, 1864 by soldiers stationed at Fort Douglas in Salt Lake City and work was begun soon after and continued for many years. The value of production for the district is in excess of 56 million dollars and ore production is thought to exceed 3.5 million tons. Lead, zinc, gold, and silver provided the principal values and were produced with lesser amounts of copper. The district mines are all found in the



RUSH VALLEY DISTRICT

1. Argent mine
2. Ben Harrison mine
3. Calumet mine
4. Galena King mine
5. Honerine mine

Figure 175: Topographic map of the Rush Valley mining district.

Adapted From: USGS Stockton 15' Quadrangle

Pennsylvanian Oquirrh Formation; ore generally occurs at the intersections of faults and fissures as replacements of favorable limestone beds (figure 176). The ore bodies are usually tabular or pipe-like in form. The Rush Valley district has a potential of 100,000 tons of lead-silver ore. To date the district has produced almost 220,000 tons of lead and more than 76,700 tons of zinc valued at $29,800,391 and $13,012,834 respectively.

Ben Harrison Mine

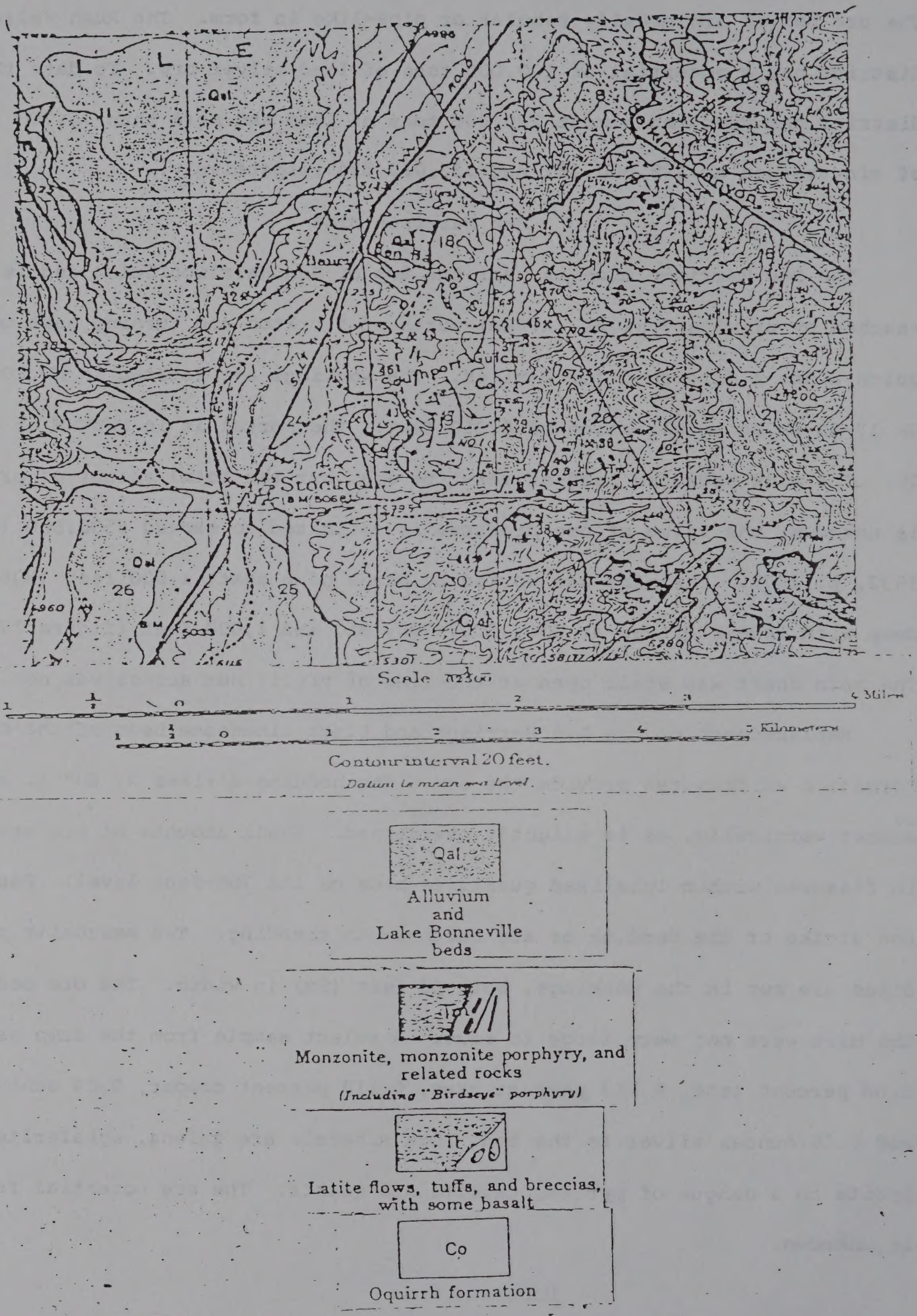
The Ben Harrison mine is near the top of Ben Harrison Gulch and is reached by driving 3 miles (4.8km) north of Stockton and turning east up the gulch along a dirt road for 3 miles. The workings are located in NW 20 and SW 17-4S-4W at an elevation of 6,350 feet. The portal is in NWNWNW of section 20. The mine produced lead-silver-zinc ore, but the total amount of production is unknown; the value of ore produced is estimated to exceed $500,000 (Gilluly, 1932, p. 157). The mine was worked by means of a shaft 1,000 feet (305m) deep with levels driven at 200, 500, 700, 850 and 1,000 feet (figure 177). The main shaft was still open at the time of visit, but access was not possible.

Replacements of the Ben Harrison and Black limestone beds of the Oquirrh Formation at fissures provide the ore. The bedding strikes N. 80° E. and dips almost vertically, or is slightly overturned. Small amounts of ore are located in fissures within localized quartzite beds on the 700-foot level. Faults follow the strike of the bedding or are north-south trending. Two monzonite porphyry dikes are cut in the workings, both 30 feet (9m) in width. The ore bodies of the mine were not very large in size. A select sample from the dump assayed 3.88 percent lead, 0.219 percent zinc, 0.119 percent copper, 0.04 ounces gold and 0.36 ounces silver to the ton. Ore minerals are galena, sphalerite, chalcopyrite in a gangue of pyrite, calcite and quartz. The ore potential for the mine is unknown.

Honerine Mine

The Honerine mine is located about a mile (1.6km) northeast of Stockton

Figure 176: GEOLOGIC MAP OF THE RUSH VALLEY MINING DISTRICT


Qal
Stockton
Soumport Gulch
Co
Scale 1/62500
1 ½ 0 1 2 3 4 Miles
1 ½ 0 1 2 3 4 5 Kilometers
Contour interval 20 feet.
Datum is mean sea level.
Qal
Alluvium and Lake Bonneville beds
Tl
Monzonite, monzonite porphyry, and related rocks (Including "Birdseye" porphyry)
Tt
Latite flows, tuffs, and breccias, with some basalt
Co
Oquirrh formation

Adapted from Gilluly, 1932, plate 12

Table 46 continued:

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1928	45,970	14,443,351	1,390,806	139,971	3,800.00	239,651	$1,159,520
1929	61,662	23,502,937	1,045,848	270,699	6,038.00	377,835	1,923,546
1930	44,561	20,313,260	715,042	168,269	4,267.00	297,327	1,274,538
1931	44,112	17,546,800	1,190,807	49,634	3,463.00	254,475	844,374
1932	25,947	14,444,232	---	18,550	1,798.00	203,033	528,906
1933	31,188	13,832,938	834,907	52,906	1,329.00	224,179	656,198
1934	35,728	11,187,973	1,717,140	102,700	1,694.28	233,091	705,908
1935	38,908	9,913,675	1,961,091	175,145	2,073.40	217,575	726,323
1936	60,645	16,381,891	2,732,220	210,522	3,159.80	327,765	1,273,993
1937	59,139	12,820,000	4,409,800	201,000	2,554.00	316,702	1,401,697
1938	41,511	9,238,000	3,909,896	153,643	2,173.00	250,883	865,922
1939	38,089	6,844,681	4,740,904	143,404	2,114.00	217,358	804,671
1940	50,641	9,520,540	5,942,000	23,133	3,221.00	310,351	1,186,416
1941	42,625	8,336,700	7,452,000	87,400	1,814.00	283,088	1,309,202
1942	41,494	7,976,400	15,249,300	71,000	1,915.00	253,523	2,208,503
1943	150,907	7,010,200	17,760,000	86,200	1,273.00	235,295	2,666,927
1944	96,290	6,585,700	12,447,500	136,600	1,975.00	227,506	2,195,219
1945	112,139	6,274,500	15,439,200	113,800	1,171.00	207,450	2,518,983
1946	115,921	6,980,000	12,730,000	511,500	1,315.00	239,375	2,636,183
1947	151,300	7,658,500	11,284,000	445,900	3,278.00	304,105	2,951,772
1948	139,284	8,369,800	7,103,600	740,200	3,264.00	348,027	3,032,819
1949	76,405	5,905,500	4,375,300	462,000	1,972.00	247,480	1,859,622
1950	14,958	2,641,800	1,633,700	45,100	375.00	95,324	697,407
1951	26,343	5,053,400	1,627,200	62,500	1,032.00	189,110	1,392,787
1952	21,062	4,904,400	1,007,100	31,000	679.00	179,401	1,151,226
1953	24,423	5,506,900	1,127,000	37,000	1,145.00	204,793	1,087,051
1954	21,472	4,907,800	1,465,000	51,000	1,168.00	181,653	1,051,037
1955	15,878	3,214,200	914,700	42,800	868.00	128,324	753,908
1956	60,009	5,058,400	3,070,100	83,100	2,035.00	198,069	1,500,578
1957	19,455	3,953,700	430,300	67,300	390.00	151,228	786,070
1958	11,570	1,740,000	250,000	50,000	265.00	87,000	335,245
1959	350	27,000	4,000	1,000	75.00	1,000	7,525
1960	?	20,600	3,800	1,300	3.00	698	4,122
1961	?	7,600	700	---	---	183	1,086
1962	?	2,900	2,700	---	1.00	164	798
1963	?	15,300	300	---	1.00	267	2,029
1964	?	6,900	100	---	---	99	1,082
1965	?	17,900	12,300	300	7.00	1,030	6,110

Table 46: Lead-zinc-copper-gold-silver production, Rush Valley mining district, 1870-1976

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1870-1900[1]	?	43,571,176	---	75,907	12,339.46	1,454,394	$3,462,824

[1] Calculated from combined Ophir-Rush Valley production figures (Gilluly, 1932)

Metals produced in the Rush Valley mining district, 1901-1927

Year	Ore (short tons)	Gold		Silver		Copper		Lead		Recoverable zinc		Total value
		Fine ounces	Value	Fine ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
1901	[a] 400	34.64	$714	6,618	$3,971	--------	--------	[a] 200,000	$8,600	--------	--------	$13,285
1902	496	64.00	1,323	7,470	3,964	--------	--------	250,651	10,271	--------	--------	15,558
1903	142	4.69	97	1,211	654	--------	--------	27,009	1,134	--------	--------	1,885
1904	[b] 44,145	292.99	6,056	176,510	101,052	5,248	$656	11,978,448	524,057	--------	--------	631,821
1905	[b] 40,431	322.00	6,656	56,025	33,839	413	65	3,499,020	155,419	--------	--------	195,970
1906	[b] [c] 37,409	398.88	8,246	95,801	64,227	3,858	745	4,082,872	284,024	--------	--------	357,242
1907	[b] 48,318	324.43	6,707	130,487	86,121	318	63	6,622,042	350,968	--------	--------	443,859
1908	[c] 2,602	14.70	304	31,386	16,635	5,779	763	1,676,217	70,401	--------	--------	88,103
1909	[b] 5,627	21.48	444	24,006	12,530	1,781	232	1,213,266	52,170	--------	--------	65,376
1910	[b] 1,981	27.32	565	15,888	8,580	10,354	1,315	965,140	42,466	--------	--------	52,926
1911	10,107	477.38	9,868	102,863	54,517	12,689	1,586	4,969,470	223,626	--------	--------	289,597
1912	[d] 45,453	1,141.31	23,593	261,588	160,877	319,859	52,777	10,971,278	493,708	--------	--------	730,955
1913	[b] [c] 14,897	585.09	12,094	128,675	77,720	29,521	4,576	4,619,259	203,247	9,010	$505	298,142
1914	19,332	420.18	8,686	108,970	60,265	21,680	2,883	3,791,497	147,868	69,582	3,549	223,251
1915	19,780	298.15	8,230	90,666	45,968	37,899	6,633	4,161,151	195,104	99,034	12,280	268,215
1916	24,710	439.31	9,081	108,841	71,617	118,943	29,260	5,413,042	373,500	136,615	28,306	501,764
1917	10,713	708.53	14,647	79,797	65,753	43,335	11,830	3,315,077	285,097	56,490	5,762	383,089
1918	8,031	432.43	8,930	78,247	73,247	26,991	6,667	3,776,351	268,121	23,089	2,101	364,075
1919	4,913	276.38	5,713	50,033	56,037	24,598	4,575	2,676,501	141,855	70,698	5,160	213,340
1920	3,103	189.96	3,927	26,978	29,406	13,259	2,440	1,553,273	124,262	25,143	2,037	162,072
1921	1,731	63.06	1,303	16,357	16,357	1,203	155	1,213,759	54,619	--------	--------	72,434
1922	1,764	70.89	1,465	17,175	17,175	3,962	535	1,172,502	64,488	19,012	1,084	84,747
1923	3,865	141.50	2,925	32,367	26,541	14,758	2,169	2,567,672	179,737	--------	--------	211,372
1924	4,549	172.91	3,575	26,519	17,768	10,198	1,336	1,851,687	148,135	16,254	1,063	171,877
1925	[f] 19,859	637.75	13,184	97,739	67,831	90,459	12,845	4,929,432	428,861	901,458	68,510	591,231
1926	[e] 36,584	1,311.99	27,119	174,667	108,992	120,081	17,651	10,044,955	803,596	1,962,198	147,165	1,104,523
1927	[g] 66,573	2,949.10	60,963	271,325	153,841	201,781	26,433	14,692,775	925,645	3,634,134	232,585	1,399,467
	477,505	11,920.95	246,424	2,218,377	1,440,485	1,124,967	188,190	113,124,359	6,560,979	7,022,826	500,107	8,936,185

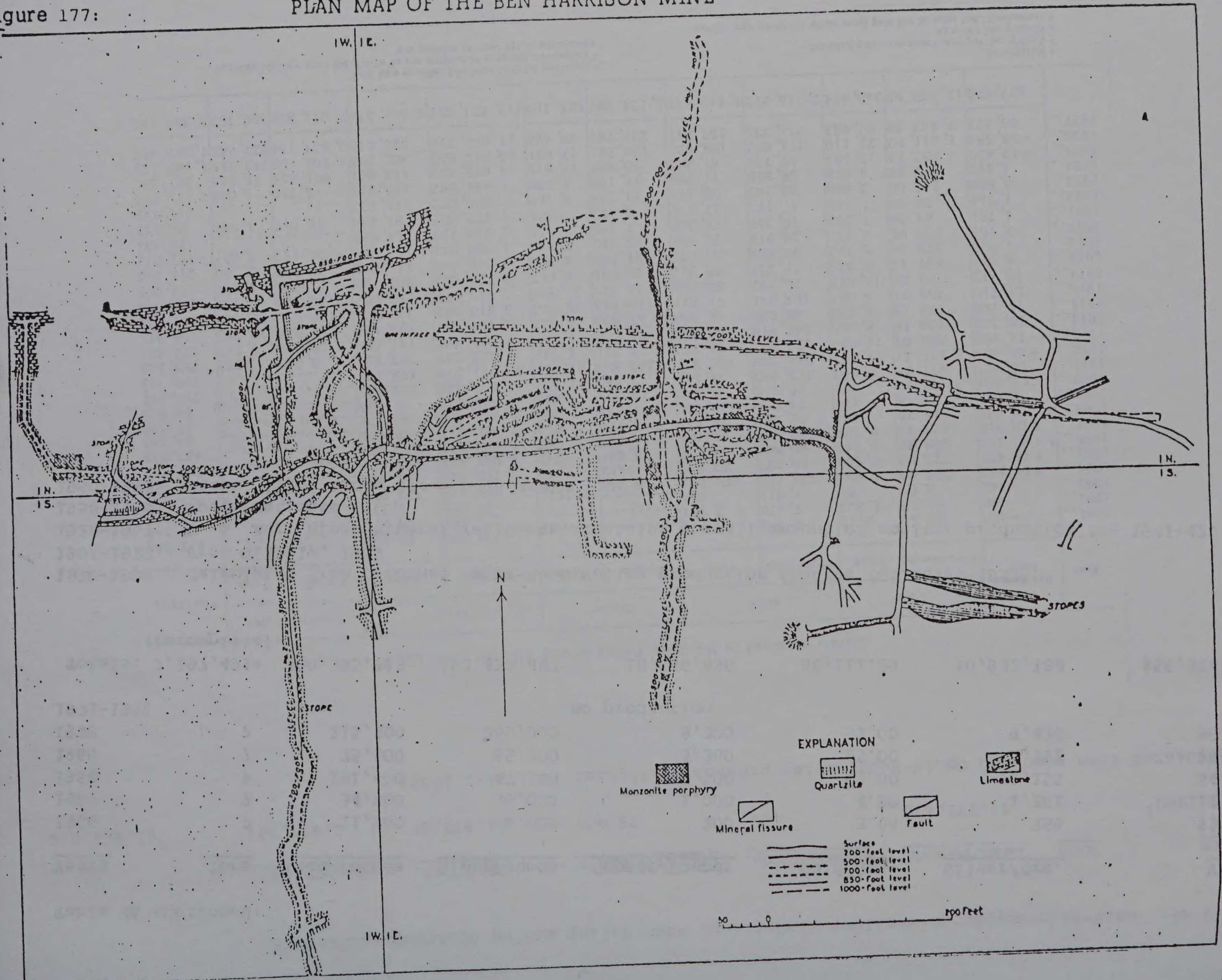
[a] Estimated.
[b] Partly milling ore, concentrates produced.
[c] Mostly old tailings.
[d] Includes 27,647 tons of old slag from early smelting operations.
[e] Includes 2,049 tons of old tailings and slag.
[f] Includes 6,021 tons of milling ore of which 500 tons was old tailings.
[g] Includes 14,787 tons of milling ore.

Table 46 continued:

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1966	?	11,900	6,000	200	3.00	756	$3,837
1967	?	34,900	36,000	1,000	4.00	1,361	12,174
1968	?	191,400	87,100	6,500	62.00	10,155	64,163
1969	?	75,500	65,300	3,300	25.00	3,292	28,978
1970	?	215,300	260,900	8,300	52.00	9,436	96,919
1971-1976				no production			
Totals:	2,197,491+ (incomplete)	439,395,913	153,458,487	18,656,456	88,111.89	10,932,188	$56,314,383

1870-1900: Calculated from combined Ophir-Rush Valley production figures (Gilluly, 1932)
1901-1927: From Gilluly, 1932
1928-1957: U. S. Bur. Mines Mineral Yearbooks, contains a small amount of smelter production for 1941-42, 45-49.
1958-1959: Rough estimate
1960-1972: Stowe, 1975, table 27.

Figure 177: PLAN MAP OF THE BEN HARRISON MINE



Adap[illegible] from Gilluly, 1932, p. 158

and is reached by a dirt road heading north of Stockton. The portal is located in SESENE 24-4S-5W at an elevation of 5,300 feet (1615m) and the workings of the mine extend into 19-4S-4W. The first work done at this locality was in 1863, at the time of discovery the mine was first known as the Connor mine. Various claims surrounding the area were soon consolidated into the Honerine mine. Workings include those of the Tiptop, Diamond, St. Patrick, Hercules, Cygnet, Bunker Hill, Legal Tender, Vulcan, and several other small mines. The Honerine mine is the largest producer in the district. Prior to 1890 the total value of production was estimated at $1,250,000 from 80,000 tons of ore (Gilluly, 1932, p. 160). Production through 1927 brought an additional 6 million dollars worth of ore. The length of workings total about 10 miles (16.1 km), not including the stopes. The mine was first worked through inclined shafts and later by a drainage tunnel driven from the town of Bauer. The tunnel is 13,000 feet (3,962m) in length and was still open in 1976. It connects with the 1200-foot level and was used to transport ore and men to the mill. In addition, water was drained out of the mine at the rate of 1500 to 1900 gallons per minute (5678-7192 lpm) during operations. The water was used in the mill and for irrigation.

Ore is primarily found in replaced limestone beds of the Oquirrh Formation near the intersections of faults and fissures. The strike of the beds is about N. 70-75° W. and the dip is 60-75 degrees northeast. There are also some monzonite porphyry dikes present, similar to those of the Ben Harrison mine. The ore was chiefly mined for lead, silver, and zinc; copper was also found in paying amounts. The ore bodies are chiefly tabular and pipe-like with an inconsistent ore grade. The average ore-grade shipped was 18 percent lead, 3 percent zinc, 6.5 ounces of silver per ton and small amounts of copper and gold.

Calumet Mine

The Calumet mine is located 1.5 miles (2.4km) east of Stockton in NENENE 30-4S-4W at an elevation of 6,025 feet (1836m). The mine first operated in the early days of the district and produced $60,000 worth of ore between World War I and 1920. Earlier production figures and values are unknown. The workings of the mine are accessible through a 600-foot (183m) shaft, but their extent is unknown. Ore is found as replaced limestone beds in the Oquirrh Formation, which strikes N. 70° W. and dips 70 degrees northeast. Ore occurs near the intersections of fissures and favorable beds. The grade of ore shipped averaged 18 percent lead, 12 ounces silver, $2.50 gold, 25 percent copper as it was being mined during World War I. Ore minerals are galena, sphalerite, chalcopyrite, gold-bearing pyrite, malachite, and copper pitch.

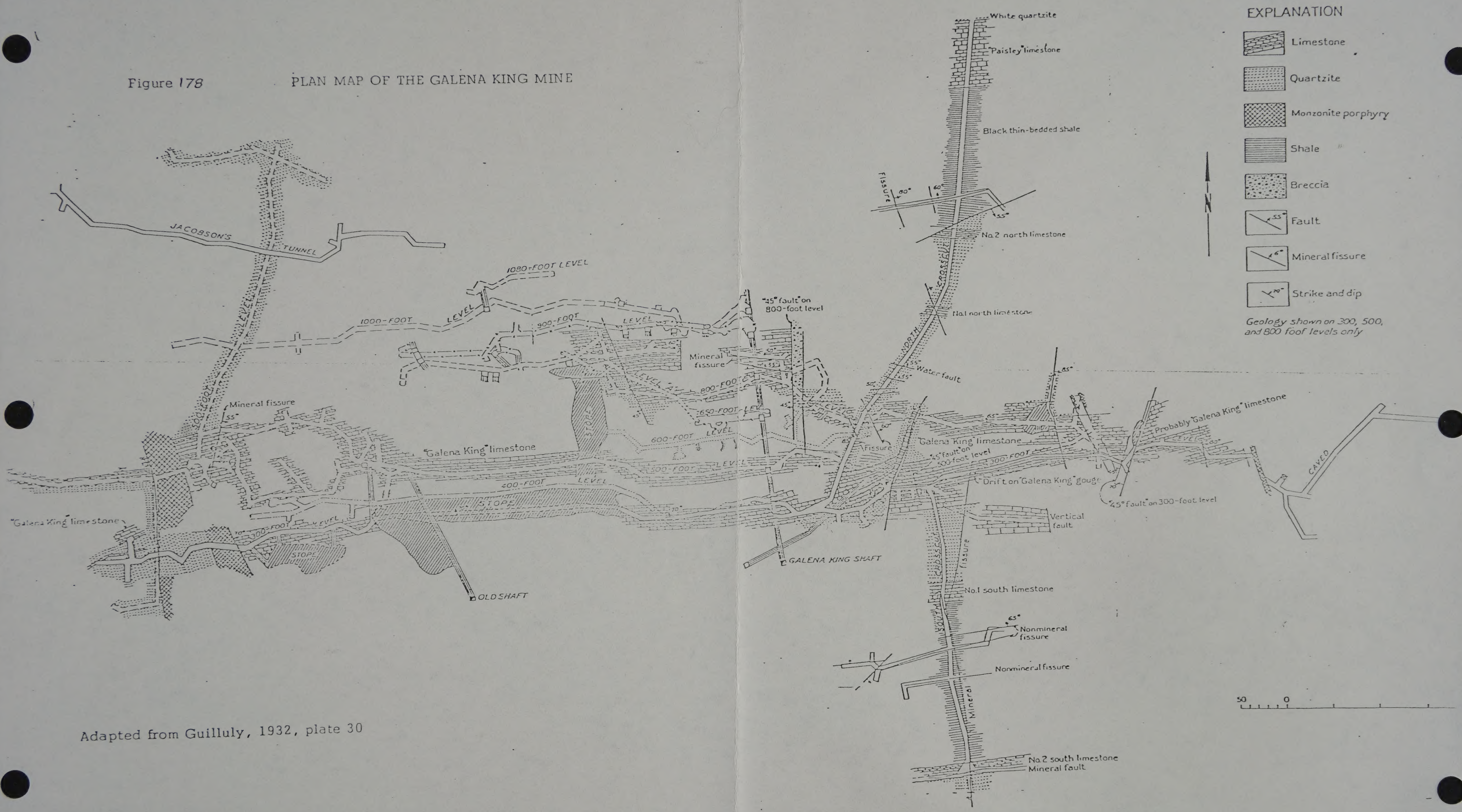
Galena King Mine

The Galena King mine is located 3 miles (4.8km) east of Stockton and about 3/4 of a mile (1.2km) north of the Calumet mine in NESESE 19-4S-4W at an elevation of 6,020 feet (1835m). The mine was one of the first worked in the district and was the first mine in Utah to ship galena ore. The total value of production has been in excess of a million dollars of lead-silver ore. It was worked through two main inclines, one going down 1,000 feet (305m) and the other 500 feet (152m). The 1,000-foot incline has levels at 300, 400, 500, 600, 650, 800, 900, and 1,000 feet. An interior winze gives access to the 1,200, 1400 and 1600-foot levels. Drifts and crosscuts are driven from these levels, some of which are quite long. The workings total approximately 8,000 feet (2438m) in length (figure 178)..

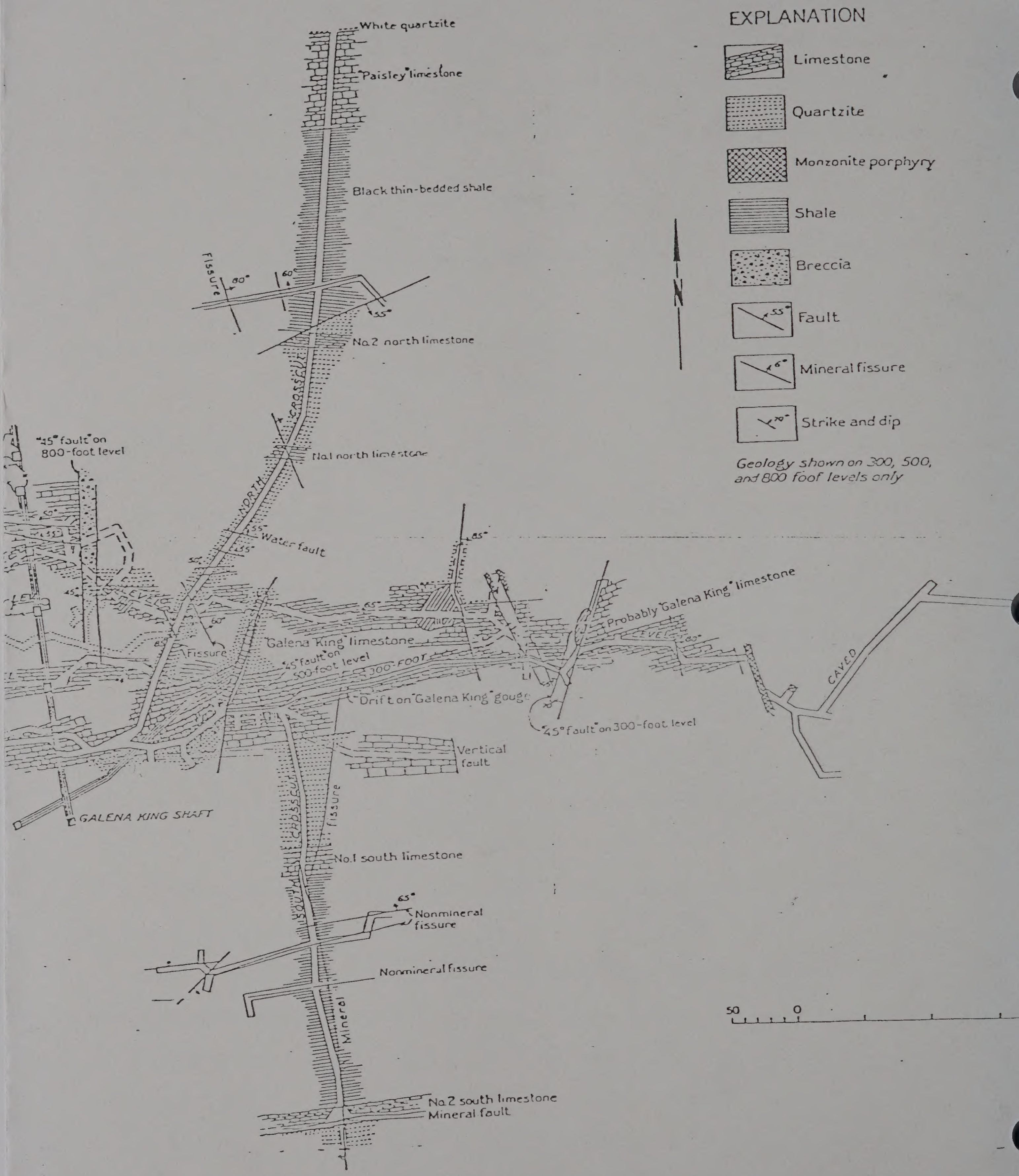
The ore is localized within two replacement limestone beds of the Oquirrh Formation which strike east-west and have a 65 degree dip to the north. Two monzonite porphyry dikes were cut by the workings. Ore is controlled by faults and fissures forming tabular and chimney-like deposits in limestone. Some of the ore bodies are 300 feet (91m) in length and between 1-6 feet (0.3-1.8m) in thickness. The ore mined was largely for lead, zinc, and silver, but gold and copper were usually present in paying amounts. The approximate ore grade in

465

Figure 178 PLAN MAP OF THE GALENA KING MINE



Adapted from Guilluly, 1932, plate 30


EXPLANATION
Limestone
Quartzite
Monzonite porphyry
Shale
Breccia
Fault
Mineral fissure
Strike and dip
Geology shown on 300, 500, and 800 foot levels only
N
50
0
White quartrite
"Paisley" limestone
Black thin-bedded shale
Fissure
80°
60°
55°
No. 2 north limestone
NORTH CROSSCUT
No. 1 north limestone
45° fault on 800-foot level
55°
Water fault
50°
85°
"Galena King" limestone
Fissure
60°
45° fault on 500-foot level
300-FOOT LEVEL
65°
Probably "Galena King" limestone
80°
Drift on "Galena King" gouge
45° fault on 300-foot level
Vertical fault
CAVED
GALENA KING SHAFT
SOUTH CROSSCUT
Fissure
No. 1 south limestone
65°
Nonmineral fissure
Nonmineral fissure
Mineral
No. 2 south limestone
Mineral fault

the early years of production was 50 percent lead, 40 ounces of silver per ton; while in later years the grade dropped to 30 percent lead and 8 ounces of silver per ton. Ore minerals include galena, sphalerite, chalcopyrite, plumbojarosite, cerussite, and gold-bearing limonite and pyrite.

Argent Mine

The Argent mine is located 3,100 feet (945m) east of the Galena King mine and 3,500 feet (1067m) northeast of the Calumet mine in NENESW 20-4S-4W at an elevation of 6,200 feet (1890m). It was worked in the early days of the district but was abandoned after a short period of production. The mine is developed by a shaft, 850 feet (259m) deep. Drifting was done on the various levels with stopes as much as 60 feet (18m) in length. Lead and silver were the primary commodities produced from this mine; the amount of production is unknown. Minerals in the mine include galena, jarosite, plumbojarosite, cerussite and limonite.

References:

Gilluly, James, 1932, Geology and ore deposits of the Stockton and Fairfield quadrangles, Utah: U. S. Geol. Survey Prof. Paper 173, 165p.

Heyl, A. V., 1963, Oxidized zinc deposits of the United States, pt. 2, Utah: U. S. Geol. Survey Bull. 1135-B, p.B60.

Huntley, D. B., 1885, The mining industries of Utah: Tenth Census of the U. S., v. 13, p. 447-450.

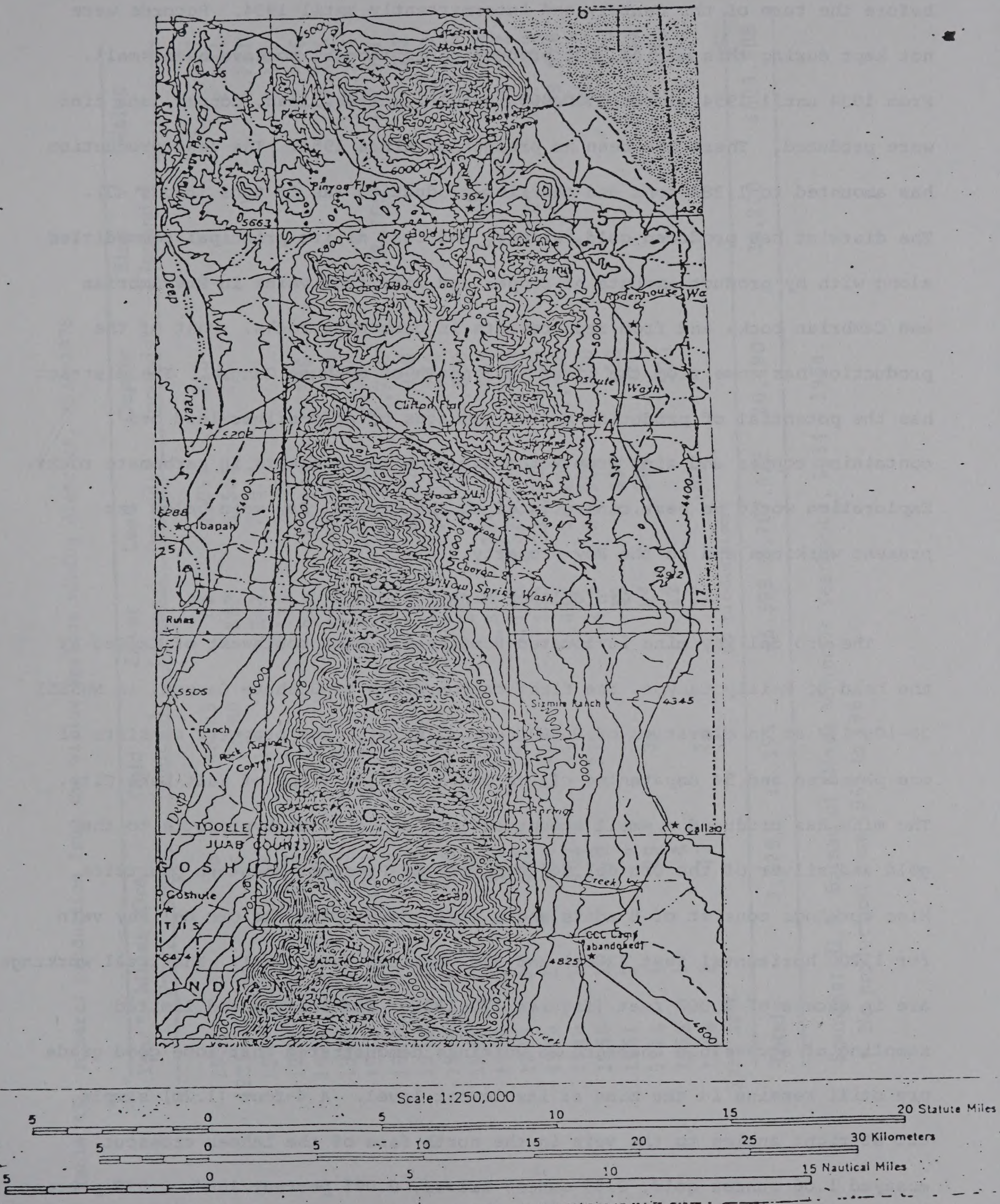
Moore, J. W. and others, 1966, Distribution of selected metals in the Stockton District, Utah: U. S. Geol. Survey Prof. Paper 550-C, p. C197-205.

Wichman, F. M., 1920, The Ophir mining district, Utah: Eng. & Min. Jour. v. 110, n. 12, p. 560-563.

Willow Springs District

The Willow Springs mining district is located in the northern end of the Deep Creek Mountains and lies south of the Gold Hill district in the southwestern part of the county. It covers the area from Toms Creek on the south to Overland Canyon on the north (figure 179). The district was first worked

Figure 179: LOCATION MAP OF THE WILLOW SPRINGS DISTRICT



Adapted from AMS Tooele and Delta 1:250,000 before the turn of the Century and intermittently until 1934. Records were not kept during this period, but production is thought to have been small. From 1934 until 1954 almost $700,000 in gold, silver, lead, copper, and zinc were produced. There has been no production since 1954. The lead production has amounted to 1,384 tons and the zinc production was 15 tons (table 47). The district has produced gold, silver, and lead as its principal commodities along with by-product amounts of copper and zinc from veins in Precambrian and Cambrian rocks and from replacements in carbonate rocks. Most of the production has come from the mines just north of Goshute Canyon. The district has the potential of producing modest tonnages of gold-silver-lead ore containing copper and zinc from veins and from replacements in carbonate rocks. Exploration would be best concentrated on the Oro del Rey vein below the present workings and on the Roy property.

Oro del Rey Mine

The Oro del Rey mine is located 8 miles 912.9km) southwest of Calleo at the head of Reilly Canyon, the first canyon north of Goshute Canyon, in NWSESE 26-10S-18W at an elevation of 8,580 feet (2,615m). The property consists of one patented and 54 unpatented claims owned by Alma Tripp of Salt Lake City. The mine has produced a small amount of lead and zinc as byproducts to the gold and silver of the Oro del Rey vein in the Prospect Mountain Quartzite. Mine workings consist of 8 adits and a shaft developing the Oro del Rey vein for 1,200 horizontal feet (366m) and 300 vertical feet (91m). The total workings are in excess of 2,000 feet (figures 180-182). Examination and limited sampling of accessible underground workings demonstrated that some good grade ore still remains in the mine at its lowest level. A 4-foot (1.2m) sample, cut at right angles to the vein in the north face of the Lehmer crosscut assayed 1.06 ounces gold, 0.57 ounces silver, 0.095 percent lead, 0.033 percent zinc and 0.3 percent copper, suggesting that this grade of ore may be encountered at depth. The authors estimate that the mine has known reserves

Table 47; Mineral production from the Willow Springs mining district, 1934-1976

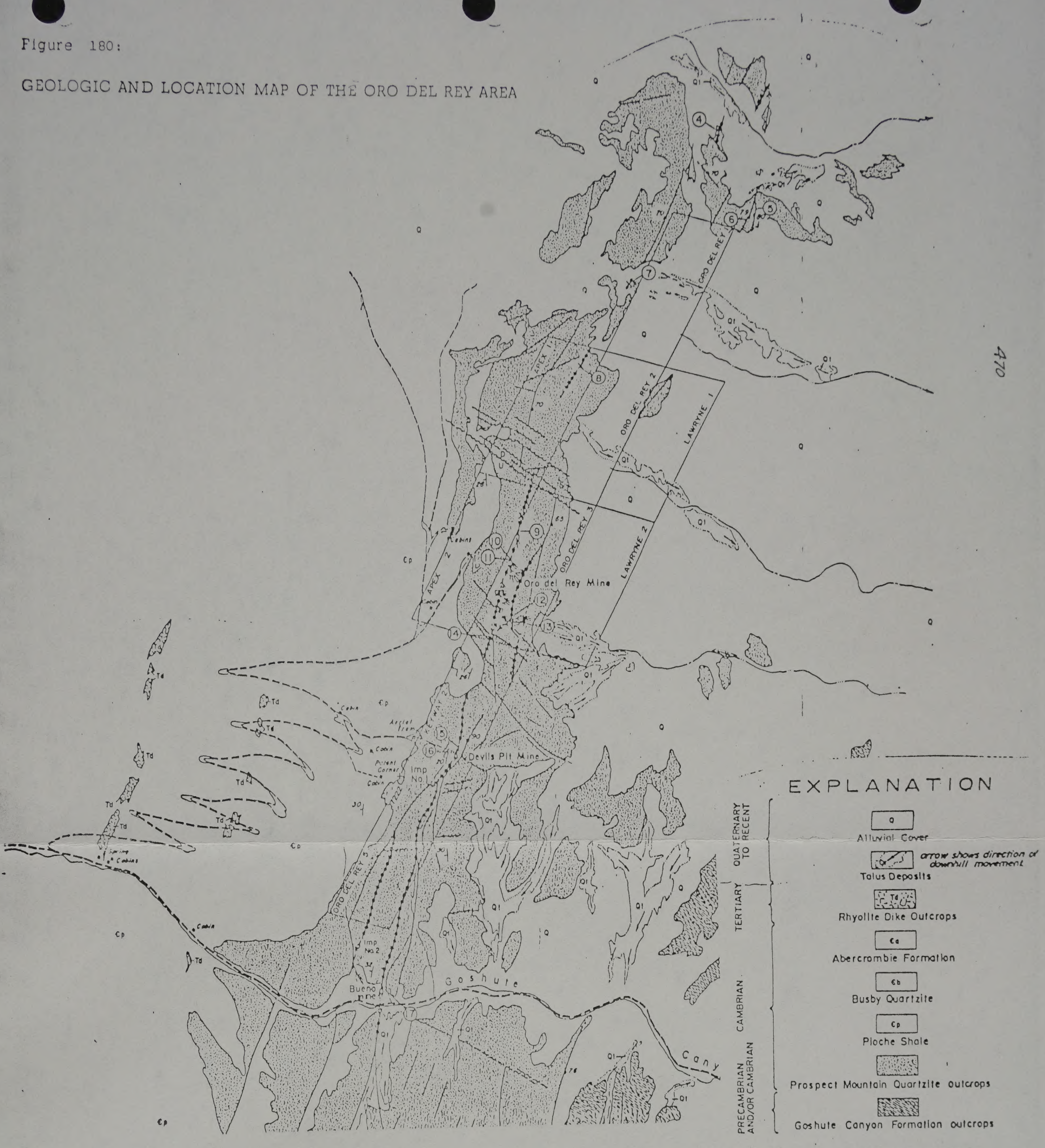
Year *	Mines Prod.	Ore (tons)	Gold (ounces)	Silver (ounces)	Lead (pounds)	Copper (pounds)	Zinc (pounds)	Value
1934	3	45	43.29	62	4,054	313		$ 1,728
1935-36	1	26	52.80	257	6,587	261		2,374
1937	1	44	118	243	7,678			4,771
1938	5	32	55	130	2,044			2,103
1939	2	207	299	940	60,149	346		13,966
1940	2	685	937	3,638	153,060	1,770		43,235
1941	4	1,381	2,871	12,811	585,000	3,000	28,700	143,294
1942	2	1,142	1,875	9,007	521,400	2,700		109,960
1943	1	284	416	2,139	144,000	900		27,073
1944	1	354	423	2,219	148,000	1,200		28,393
1945	2	289	357	1,575	85,000	2,600	1,000	21,276
1946	2	372	453	2,365	234,000	500		43,475
1947	3	652	694	4,158	328,500	3,500	200	76,092
1948	1	844	1,523	4,350	335,700	1,200	300	117,619
1949	1	403	635	2,412	96,100	1,000		39,826
1950	1	218	379	1,116	50,000	600		21,150
1951	1	4		53	600	100		176
1952	1	29	39	84	3,000			1,924
1953	1	4		12		500		154
1954	1	11	26	27	600			1,016
1955-1976				no production				
Totals		7,026	11,195	45,598	2,767,472	20,490	30,200	$699,605

Sources: U.S. Bureau of Mines Minerals Yearbooks, 1934 - 1954.

* No production from 1955 to 1968.

Figure 180:

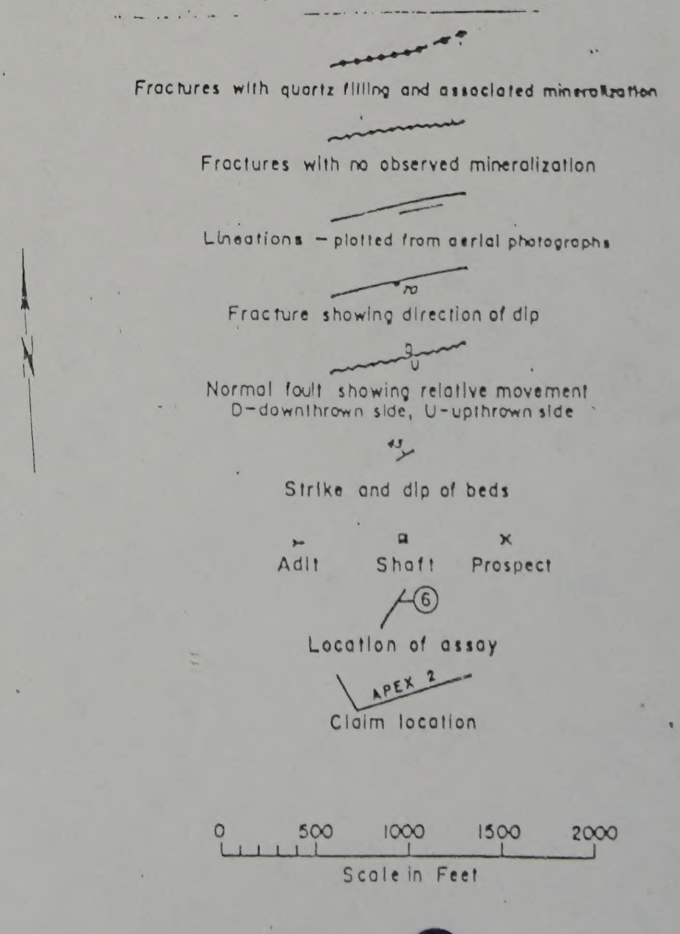
GEOLOGIC AND LOCATION MAP OF THE ORO DEL REY AREA



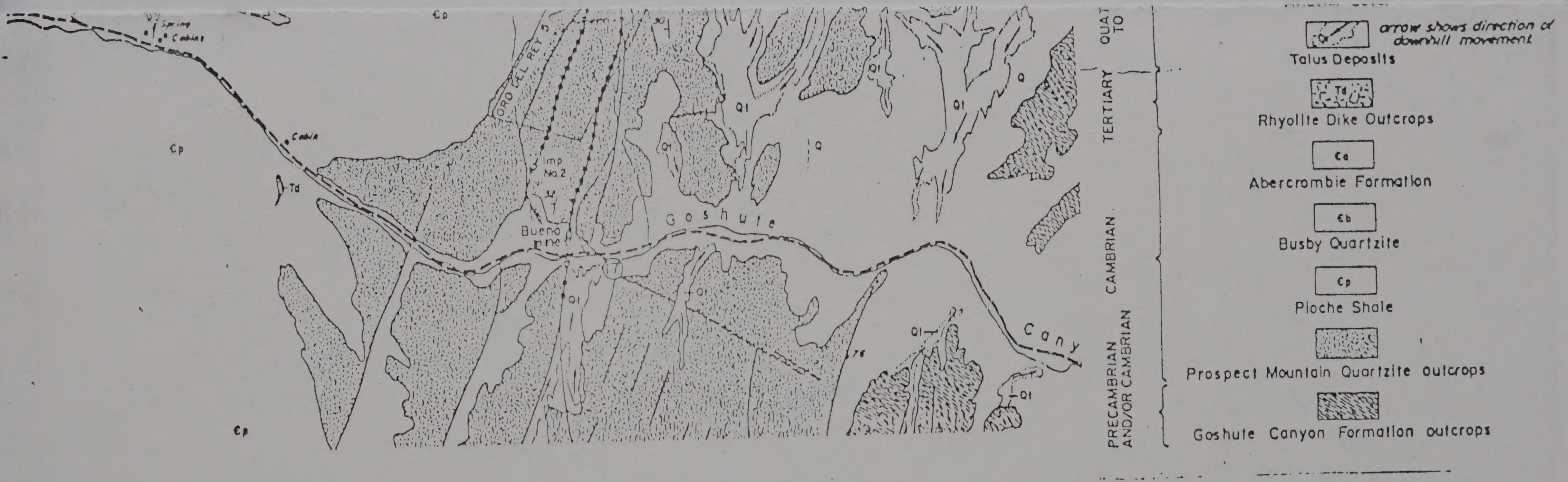
ASSAYS:

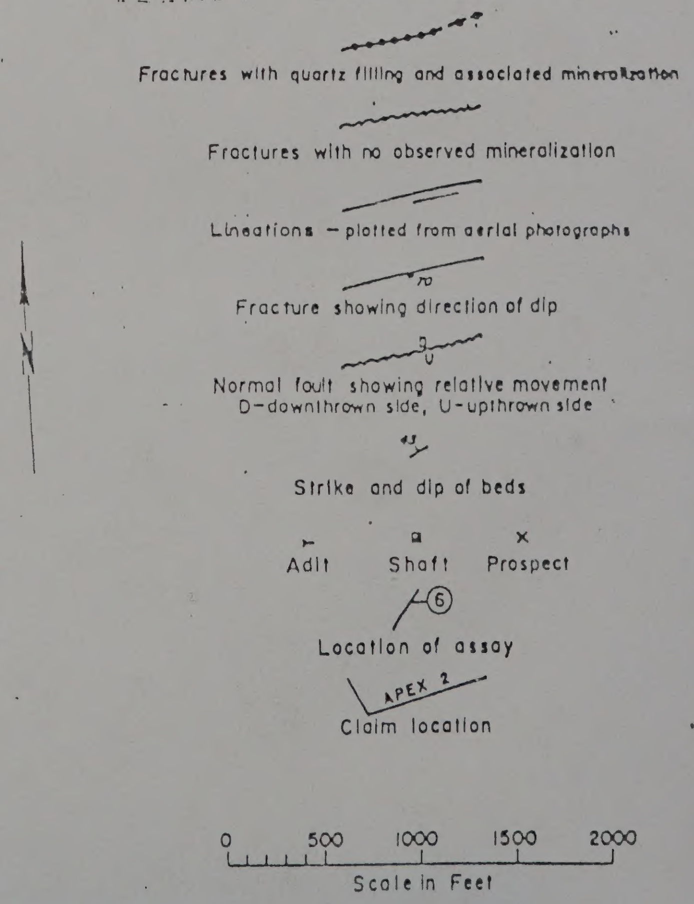
Sample No.	Width (Ft)	Ounces per ton		Percent		
		Gold	Silver	Lead	Copper	Zinc
1	0.5	Trace	3.0	10.0	11.6	0
2	2.0	0.02	Trace	0.3	0	0
3	2.0	3.90	0.6	—	—	—
4	0.5	Trace	Trace	1.0	0.10	0
5	0.5	Trace	Trace	0	0	0
6	0.5	0.05	Trace	—	—	—
7	2.0	Trace	Trace	0	0	0
8	2.0	1.20	0.8	0.5	0.10	0
9	2.0	Trace	Trace	0	0	0
10	1.0	0.40	0.2	2.0	—	—
11	1.5	1.80	2.2	6.3	—	—
12	3.0	4.30	20.0	1.7	14.4	—
13	4.0	0.40	1.2	2.4	—	—
14	1.8	0.40	0.2	2.0	—	—
15	1.0	2.50	2.0	8.7	—	—
16	1.0	0.24	0.2	—	0.15	—
17	0.5	1.96	1.0	0.4	0	—
18	1.0	Trace	Trace	0	0	0

Assays by Black and Deason, Salt Lake City, Utah


Fractures with quartz filling and associated mineralization
Fractures with no observed mineralization
Lineations — plotted from aerial photographs
70
Fracture showing direction of dip
D
U
Normal fault showing relative movement
D-downthrown side, U-upthrown side
43
Strike and dip of beds
Adit
Shaft
Prospect
6
Location of assay
APEX 2
Claim location
0
500
1000
1500
2000
Scale in Feet

apted from Thomson, plate 7





Fractures with quartz filling and associated mineralization
Fractures with no observed mineralization
Lineations – plotted from aerial photographs
70
Fracture showing direction of dip
D
U
Normal fault showing relative movement D–downthrown side, U–upthrown side
45
Strike and dip of beds
Adit
Shaft
Prospect
6
Location of assay
APEX 2
Claim location
0
500
1000
1500
2000
Scale in Feet

ASSAYS:

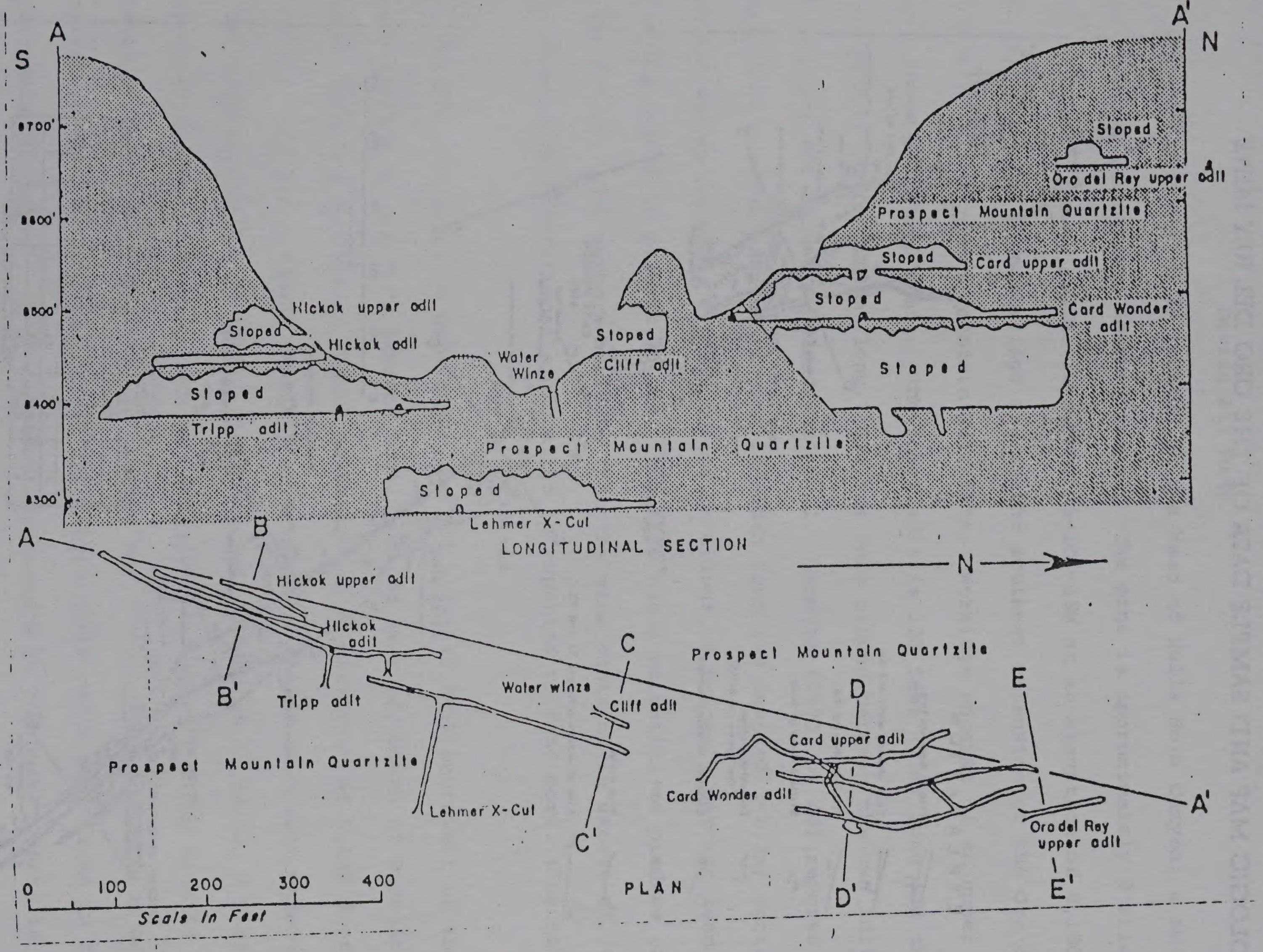
Sample No.	Width (Ft)	Ounces per ton		Percent		
		Gold	Silver	Lead	Copper	Zinc
1	0.5	Trace	3.0	10.0	11.6	0
2	2.0	0.02	Trace	0.3	0	0
3	2.0	3.90	0.6	—	—	—
4	0.5	Trace	Trace	1.0	0.10	0
5	0.5	Trace	Trace	0	0	0
6	0.5	0.05	Trace	—	—	—
7	2.0	Trace	Trace	0	0	0
8	2.0	1.20	0.8	0.5	0.10	0
9	2.0	Trace	Trace	0	0	0
10	1.0	0.40	0.2	2.0	—	—
11	1.5	1.80	2.2	6.3	—	—
12	3.0	4.30	20.0	1.7	14.4	—
13	4.0	0.40	1.2	2.4	—	—
14	1.8	0.40	0.2	2.0	—	—
15	1.0	2.50	2.0	8.7	—	—
16	1.0	0.24	0.2	—	0.15	—
17	0.5	1.96	1.0	0.4	0	—
18	1.0	Trace	Trace	0	0	0

Assays by Black and Deason, Salt Lake City, Utah

apted from Thomson, plate 7

Figure 181:

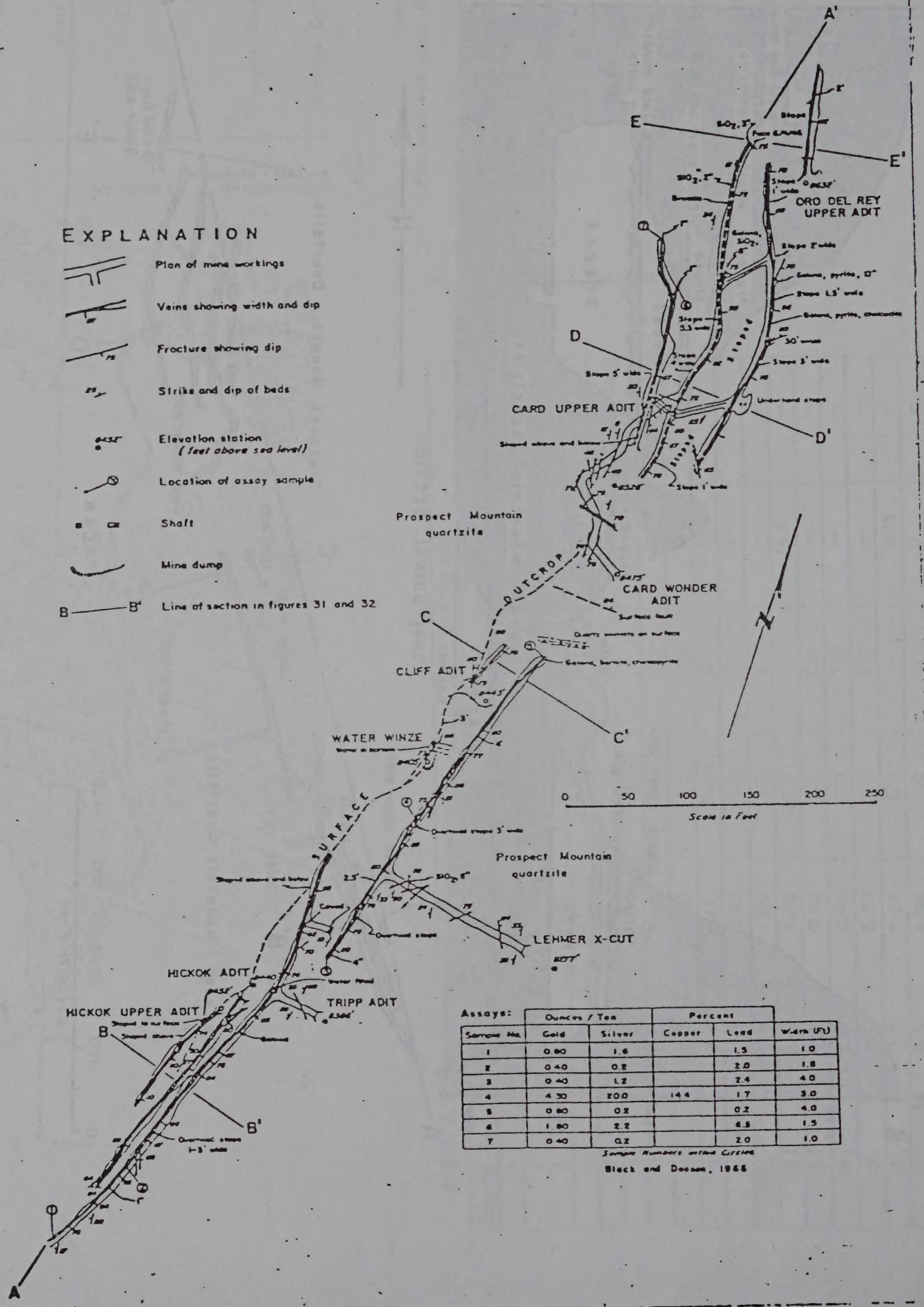
PLAN AND SECTION OF THE ORO DEL REY MINE



Adapted from Thomson, 1973, p. 42

Figure 182:

GEOLOGIC MAP AND SAMPLE DATA OF THE ORO DEL REY MINE



Assays:

Sample No.	Ounces / Ton		Percent		Width (Ft)
	Gold	Silver	Copper	Lead	
1	0.80	1.6		1.5	1.0
2	0.40	0.2		2.0	1.8
3	0.40	1.2		2.4	4.0
4	4.30	20.0	14.4	1.7	3.0
5	0.80	0.2		0.2	4.0
6	1.80	2.2		6.3	1.5
7	0.40	0.2		2.0	1.0

Sample Numbers within Circles

Black and Dobson, 1966

Adapted from Thomson, 1973, p. 41

in excess of 200 tons averaging 0.3 ounces gold, 0.5 ounces silver and minor amounts of lead, zinc, and copper.

Devils Pit Mine

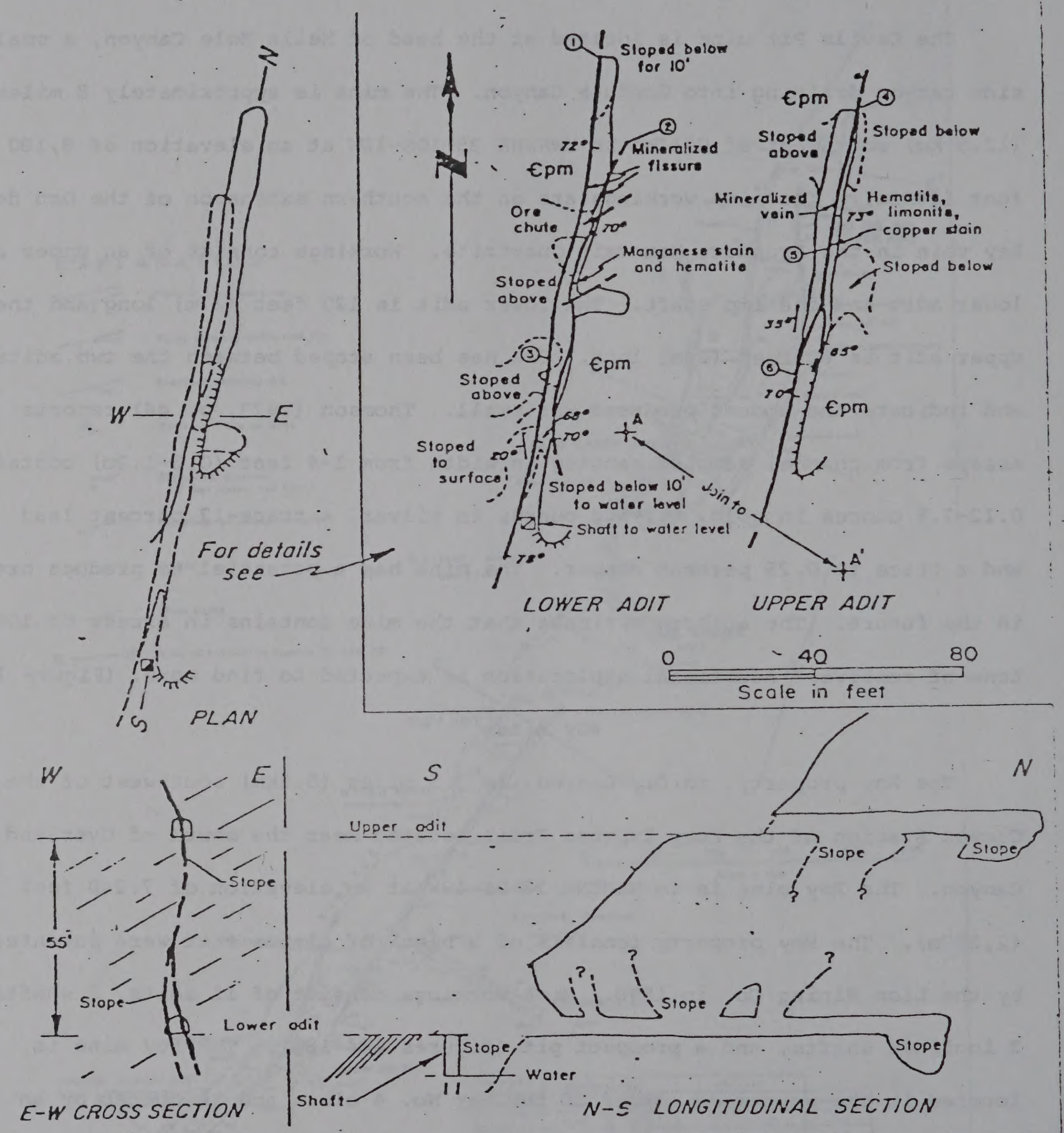
The Devils Pit mine is located at the head of Hells Hole Canyon, a small side canyon draining into Goshute Canyon. The mine is approximately 8 miles (12.9 km) southwest of Calleo in NWSWNE 35-10S-18W at an elevation of 8,180 feet (2493m). The mine workings are on the southern extension of the Oro del Rey vein in the Prospect Mountain Quartzite. Workings consist of an upper and lower adit and the Imp shaft. The lower adit is 120 feet (37m) long and the upper adit is 80 feet (24m) long. Ore has been stoped between the two adits and indicate the amount produced was small. Thomson (1973, p. 44) reports assays from channel samples ranging in width from 1-4 feet (0.3-1.2m) containing 0.12-2.5 ounces in gold, 0.1-5.2 ounces in silver, a trace-17 percent lead and a trace to 0.25 percent copper. The mine has a potential to produce ore in the future. The authors estimate that the mine contains in excess of 100 tons of reserve. Additional exploration is expected to find more. (Figure 183)

Roy Mine

The Roy property, in Dry Canyon, is 3.5 miles (5.6km) southwest of the Canyon Station of the Pony Express Trail located near the mouth of Overland Canyon. The Roy mine is in NENENE 33-9S-18W at an elevation of 7,240 feet (2,207m). The Roy property consists of a block of claims that were patented by the Lion Mining Co. in 1898. Mine workings consist of 11 adits, 2 shafts, 2 inclined shafts, and a prospect pit (figures 184-186). The Roy mine is located in the northwest corner of the Roy No. 4 claim and is opened by an inclined shaft. Mineralization occurs along a north-south fault zone in the Abercrombie Limestone. Mineralization also occurs in the Busby Quartzite and Pioche Shale. Minerals found in the ore are galena, sphalerite, cerussite, smithsonite, malachite, limonite and quartz. There are no known reserves on the property, but the possibility of finding additional ore appears good.

Figure 183:

GEOLOGY AND WORKINGS IN PLAN AND SECTION OF THE DEVILS PIT MINE



EXPLANATION

Єpm Prospect Mountain Quartzite

Mineralized fissure or fault

23° Strike and dip of beds

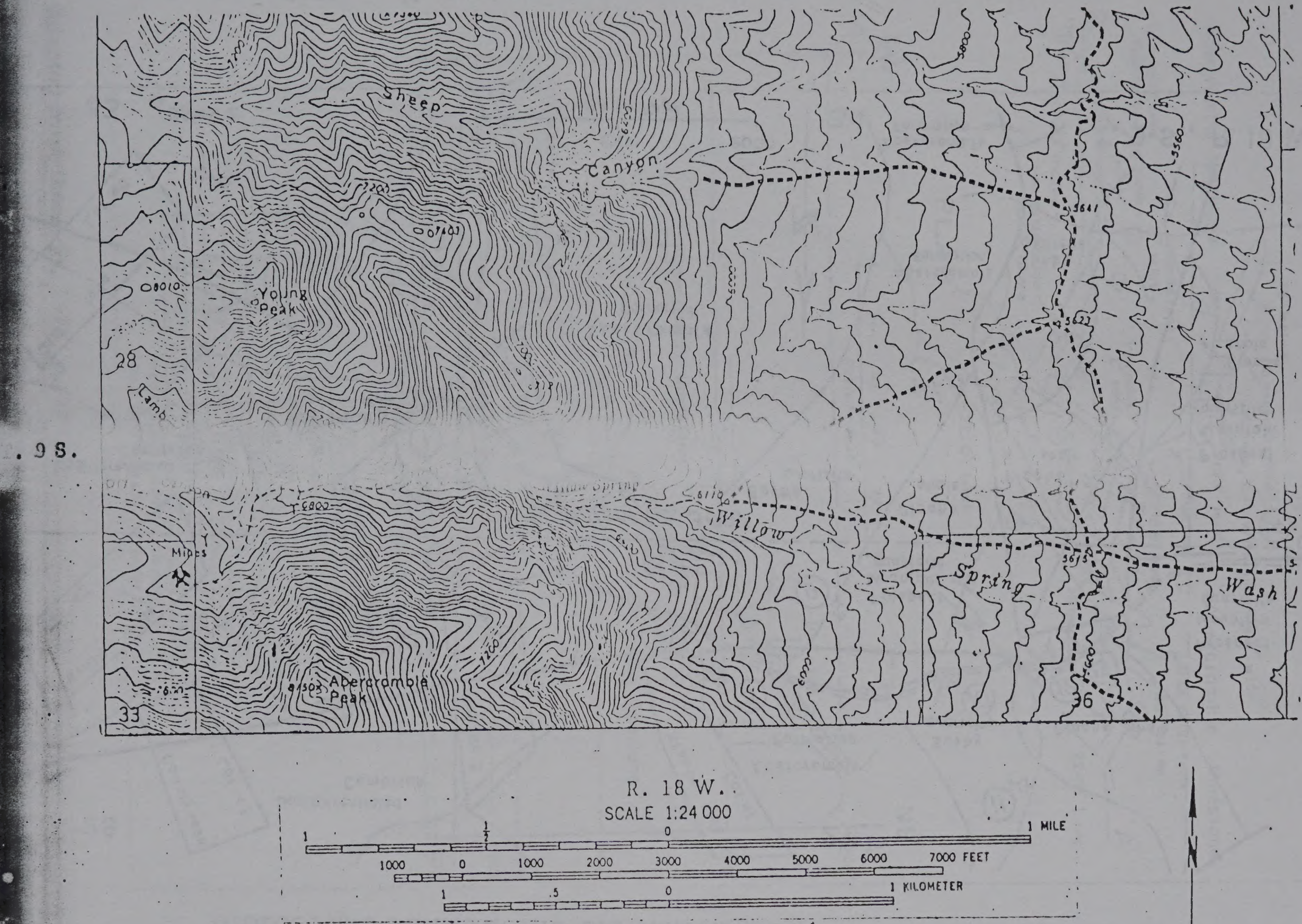
② Sample site

Assays:	Ounces/Ton		%		Width (ft.)
Sample No.	Gold	Silver	Pb	Cu	
1	0.12	0.5	1.8	–	4.0
2	0.015	0.1	–	–	0.5
3	0.24	0.2	–	0.15	1.0
4	0.30	5.2	10.0	0.25	4.0
5	2.50	2.0	8.7	–	1.0
6	1.64	4.5	17.0	0.20	1.0

Adapted from Thomson, 1973, p. 44

Figure 184;

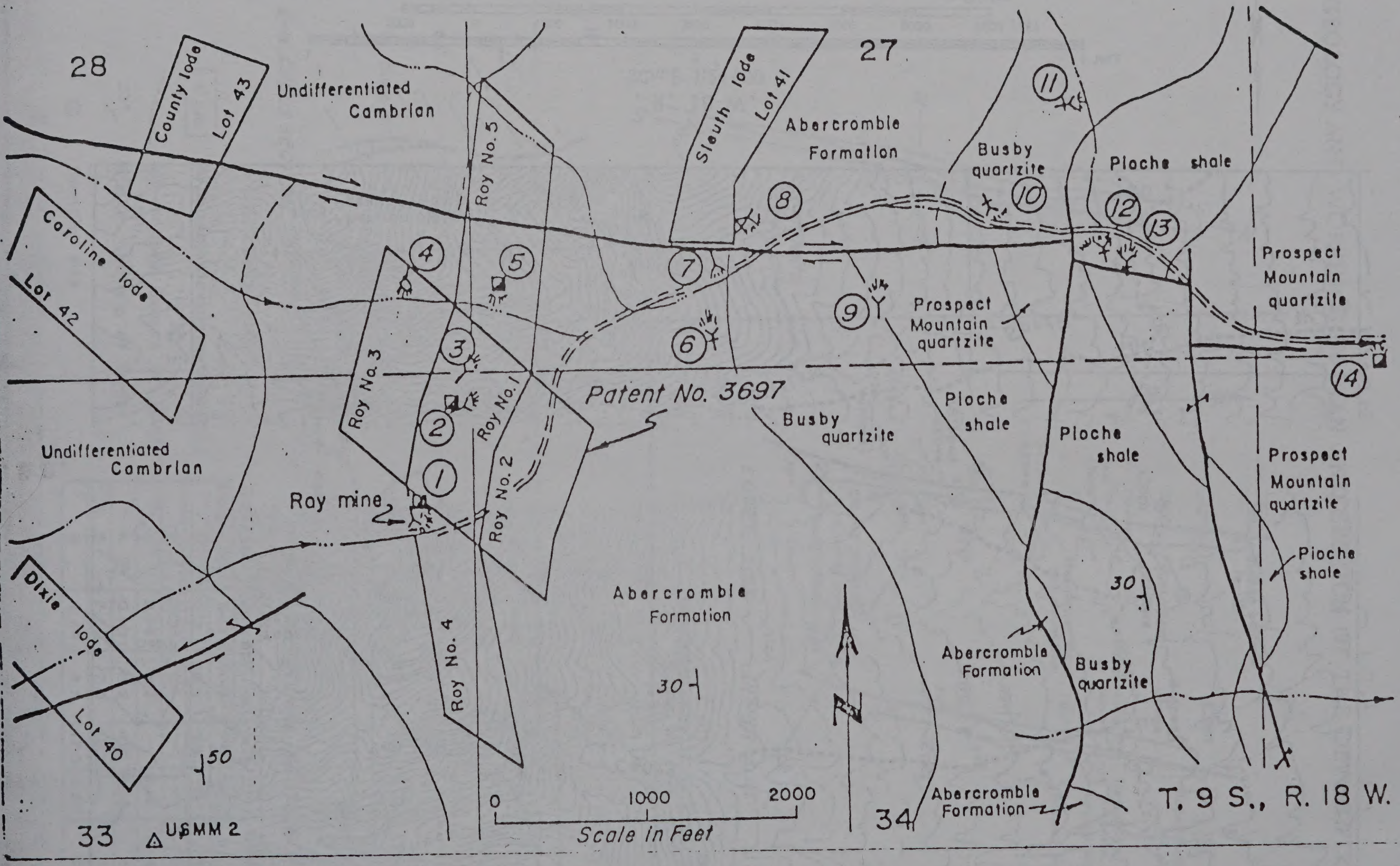
LOCATION MAP OF THE ROY MINE



Adapted from USGS Clifton 7½' quadrangle

Figure 185:

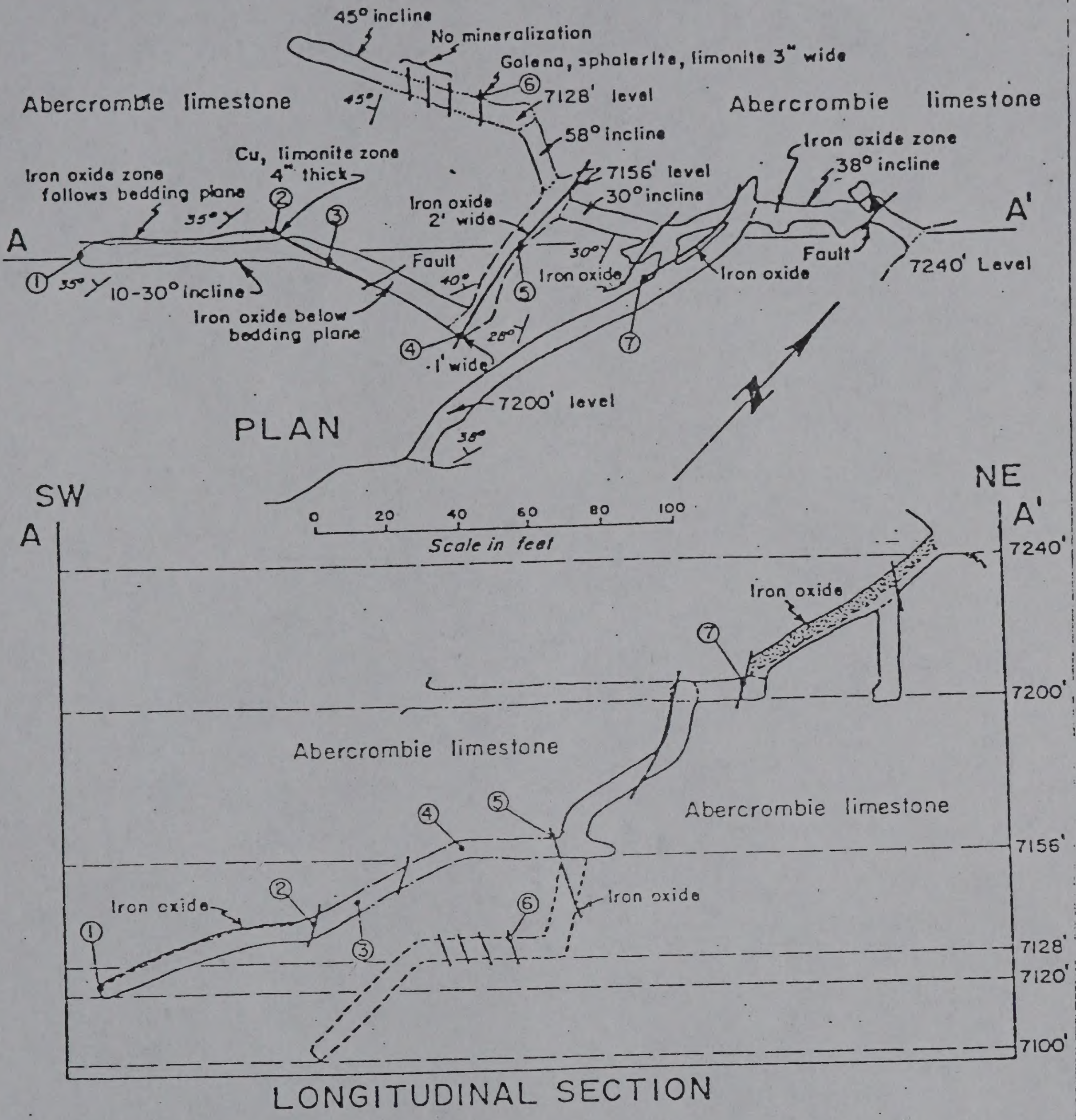
GEOLOGY AND CLAIMS IN THE DRY CANYON AREA



Adapted from Thomson, 1973, p. 33

Figure 186:

GEOLOGY AND WORKINGS IN PLAN AND SECTION OF THE ROY MINE



Assays—

Number	Width (ft.)	Ounces/ton Gold	Ounces/ton Silver	% Lead
1	4	Tr.	Tr.	—
2	4	0.005	2.0	2.5
3	4	0.005	4.4	2.0
4	1	Tr.	0.4	1.3
5	1	0.015	36.0	12.5
6	0.3	0.015	44.4	43.0
7	0.7	Tr.	4.8	1.0

Assay number circled on map
Black and Deason, assayers.

Adapted from Thomson, 1973, p. 34

Reference:

Thomson, K. C., 1973, Mineral deposits of the Deep Creek Mountains, Tooele and Juab Cos., Utah: Utah Geol. and Mineral Survey Bull. 99, 76p.

UINTAH COUNTY

Uintah County is located in the eastern part of Utah immediately south of the Uinta Mountains (figure 187). A minor amount of lead and zinc production has been realized from copper mines located in Mississippian limestones and dolomites on the south flank of the Uinta Mountains. These mines are all part of the Carbonate mining district. In all, less than 10 tons of lead and 3 tons of zinc have been produced; this production along with that of copper, gold and silver is listed in table 48. Much of the gold and some of the silver was derived from placer operations on the Green River.

Carbonate District

This is a small district of copper mines and prospects located about 20 miles (32km) north of Vernal in Ashley National Forest. The district is on the southern slopes of the Uinta Mountains and the mines are located west of Utah Highway 44. Development consists mostly of shallow prospect pits, only a few adits and shafts are present. Most of the district's production occurred from 1891 to 1904, when a blast furnace smelter was in operation. Mining was pursued somewhat regularly until 1941, thereafter production occurred only on an occasional year. Some exploration work has been done in later years, but the results of it are unknown.

The rocks exposed range in age from Precambrian to Mississippian, with the Mississippian limestones mineralized by replacement (figures 188 and 189). No structural control is evident, the beds dip moderately (20°) to the south. The ore is mostly high-grade, but of limited extent. The ore potential is minor. The district has produced mostly copper together with byproduct amounts of lead, zinc, and silver. The principal mine, the Dyer, produced only copper and silver. In terms of lead and zinc, the Silver King and Brush Creek mines are more important.

Silver King Mine

The Silver King mine is located south-southeast of Dyer Mountain in NENESW

480

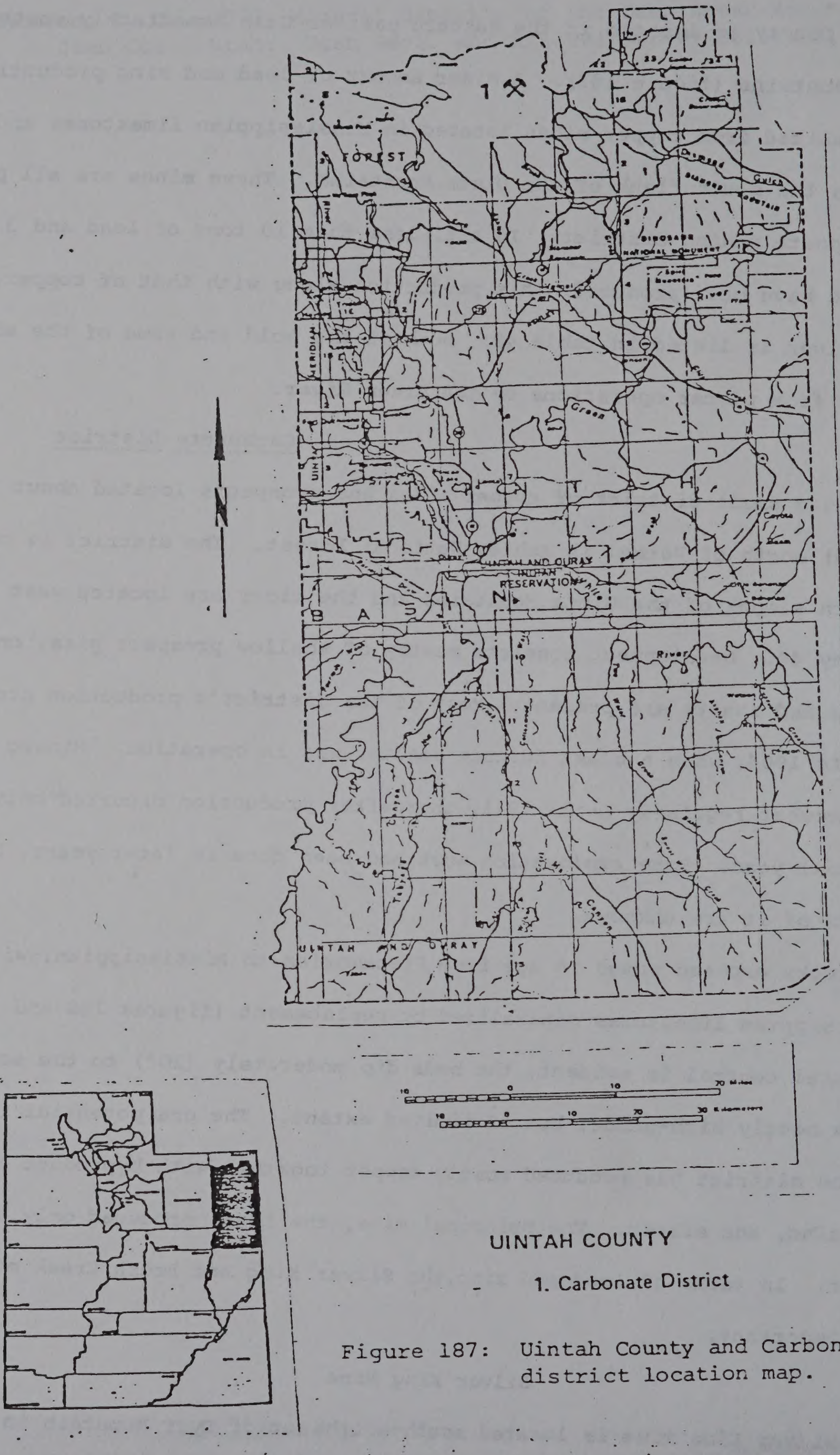
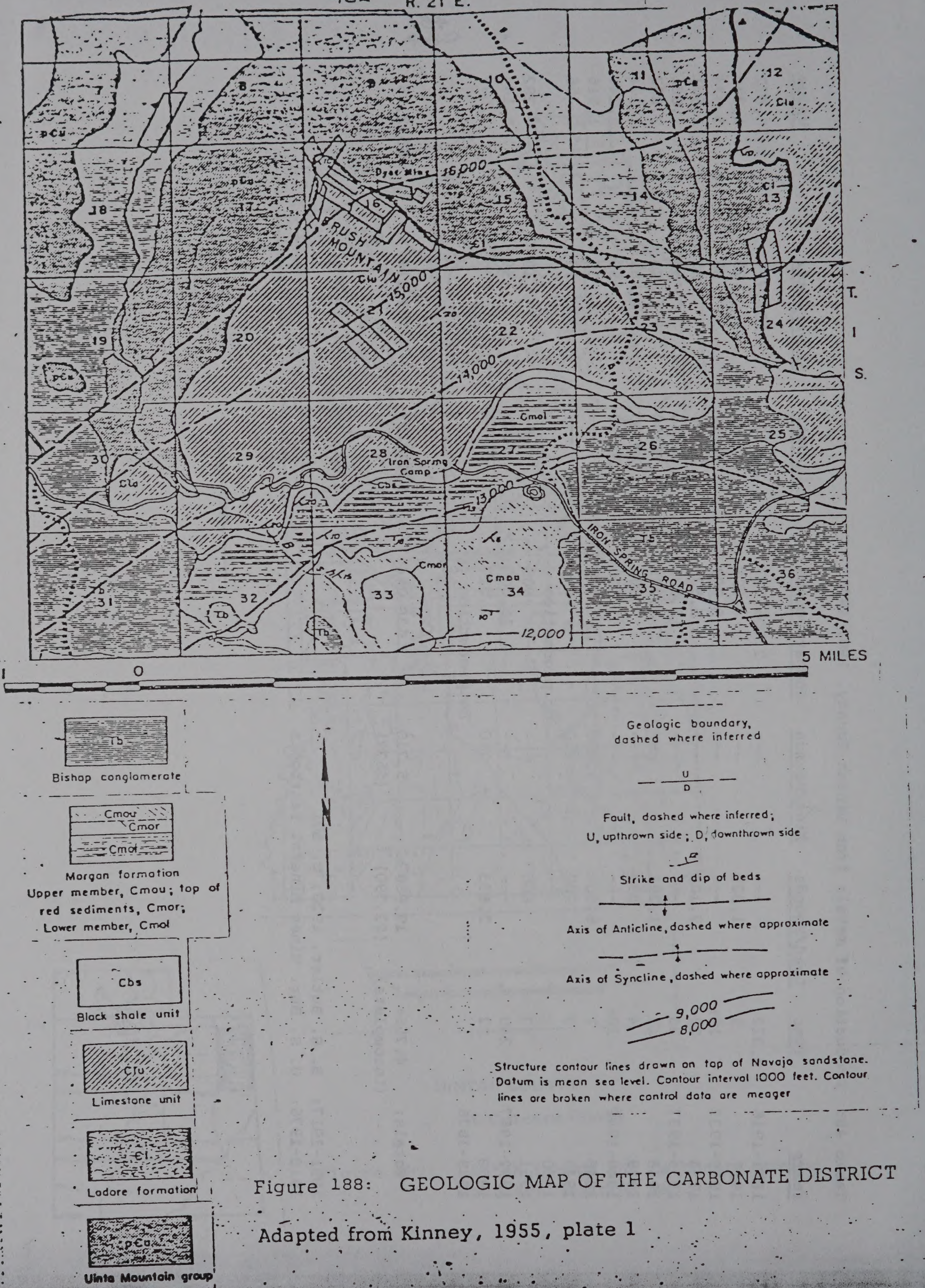


Figure 187: Uintah County and Carbonate mining district location map.

Table 48: Production of metals from Uintah County, 1891-1976

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1891-1916	4,372	---	---	2,585,147	912.21	102,727	$476,872
1917	5	1,328	---	4,098	---	20	1,250
1918-1933	16+	---	---	8,289	96.22	55	3,374
1934	23	7,108	---	5,537	21.80	51	1,501
1935-1937	33	---	---	12,635	11.00	65	1,631
1938	11	1,261	---	1,235	76.00	20	2,852
1939	4	830	---	596	29.00	81	1,171
1940-1947	10+	---	---	1,100	431.00	55	15,249
1948	?	6,000	4,800	200	---	32	1,516
1949	3	200	200	---	---	10	66
1950				no production			
1951	7	600	---	700	---	10	282
1952-1957	249	---	---	16,000	1.00	156	6,144
1958	22	2,633	710	2,527	---	36	1,077
1959-1976				no production			
Totals:	4,755+ (Incomplete)	19,960 ($1,790)	5,710 ($677)	2,638,064	1,578.23	103,318	$512,985

1891-1917: B. S. Butler, 1920, p. 601
1918-1976: U. S. Bur. Mines Mineral Yearbooks


R. 21 E.
T. 1 S.
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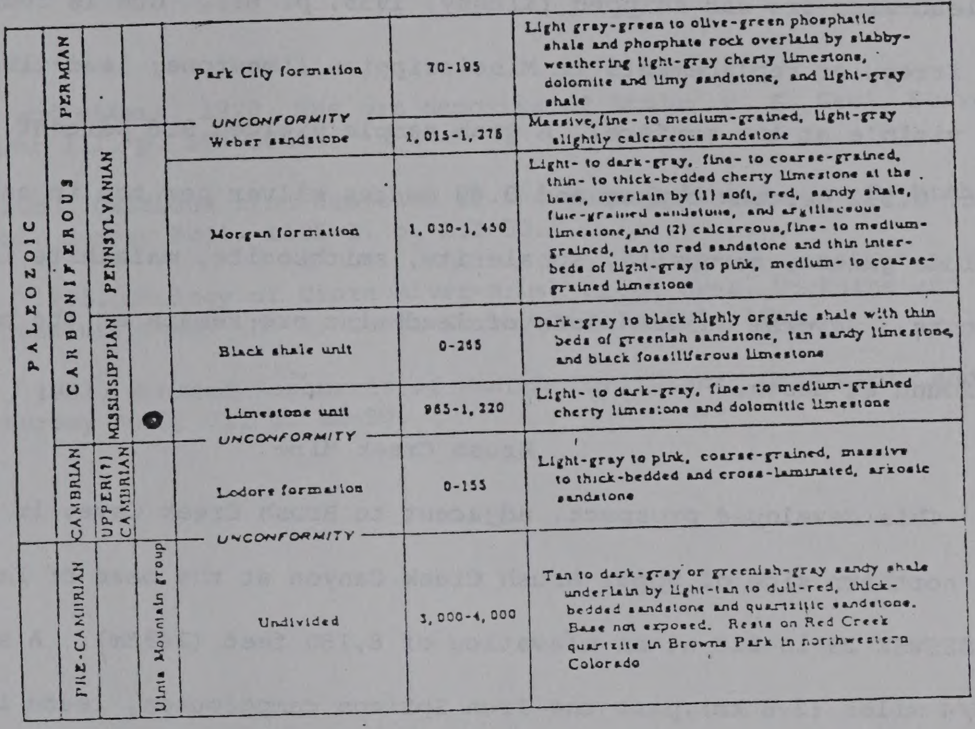
26
25
31
32
33
34
35
36
pCu
Dyer Mine
16,000
15,000
14,000
13,000
12,000
BRUSH MOUNTAIN
Iron Spring Camp
IRON SPRING ROAD
BLIS SAK
Cmol
Cmor
Cmou
Cbs
Clu
Cl
Tb
5 MILES
1
0
Tb
Bishop conglomerate
Cmou
Cmor
Cmol
Morgan formation Upper member, Cmou; top of red sediments, Cmor; Lower member, Cmol
Cbs
Black shale unit
Clu
Limestone unit
Cl
Lodore formation
pCu
Uinta Mountain group
N
Geologic boundary, dashed where inferred
U
D
Fault, dashed where inferred; U, upthrown side; D, downthrown side
Strike and dip of beds
Axis of Anticline, dashed where approximate
Axis of Syncline, dashed where approximate
9,000
8,000
Structure contour lines drawn on top of Navajo sandstone. Datum is mean sea level. Contour interval 1000 feet. Contour lines are broken where control data are meager

Figure 188: GEOLOGIC MAP OF THE CARBONATE DISTRICT

Adapted from Kinney, 1955, plate 1

Figure 189:

GENERAL SECTION OF ROCK FORMATION IN AREAS BETWEEN UINTA RIVER AND BRUSH CREEK



PALEOZOIC	PERMIAN			Park City formation	70-195	Light gray-green to olive-green phosphatic shale and phosphate rock overlain by slabby-weathering light-gray cherty limestone, dolomite and limy sandstone, and light-gray shale
				UNCONFORMITY		
	CARBONIFEROUS	PENNSYLVANIAN		Weber sandstone	1,015-1,275	Massive, fine- to medium-grained, light-gray slightly calcareous sandstone
				Morgan formation	1,030-1,450	Light- to dark-gray, fine- to coarse-grained, thin- to thick-bedded cherty limestone at the base, overlain by (1) soft, red, sandy shale, fine-grained sandstone, and argillaceous limestone, and (2) calcareous, fine- to medium-grained, tan to red sandstone and thin interbeds of light-gray to pink, medium- to coarse-grained limestone
		MISSISSIPPIAN		Black shale unit	0-265	Dark-gray to black highly organic shale with thin beds of greenish sandstone, tan sandy limestone, and black fossiliferous limestone
			●	Limestone unit	965-1,320	Light- to dark-gray, fine- to medium-grained cherty limestone and dolomitic limestone
				UNCONFORMITY		
	CAMBRIAN	UPPER(?) CAMBRIAN		Lodore formation	0-155	Light-gray to pink, coarse-grained, massive to thick-bedded and cross-laminated, arkosic sandstone
				UNCONFORMITY		
	PRE-CAMBRIAN		Uinta Mountain group	Undivided	3,000-4,000	Tan to dark-gray or greenish-gray sandy shale underlain by light-tan to dull-red, thick-bedded sandstone and quartzitic sandstone. Base not exposed. Rests on Red Creek quartzite in Browns Park in northwestern Colorado

Adapted from Kinney, 1955, plate 6

● Ore-bearing horizon

21-1S-21E at an elevation of 9,180 feet (2798m). This patented group of claims has been worked sporadically, ore was removed by means of open pit work with a dozer for the most part, a few shallow shafts are also found on the property. Prior to 1947 the only shipment from this property was 12 tons of hand-sorted ore assaying 25 percent lead, 17 percent zinc, 1.5 percent copper, 2 ounces of silver and 0.02 ounces of gold per ton. In 1947 34 tons of lead-zinc ore was shipped (Kinney, 1955, p. 89). Ore is found as scattered and irregular replacements in Mississippian limestone; lead-zinc sulphides are visible at the surface. A grab sample yielded 9.8 percent lead, 20.3 percent zinc, 0.532 percent copper and 0.49 ounces silver per ton in assay. Minerals include galena, cerussite, sphalerite, smithsonite, malachite in a gangue of calcite. Several hundred tons of lead-zinc ore remain at the mine, more may be found at depth.

Brush Creek Mine

This developed prospect, adjacent to Brush Creek Cave, is located on the northern side of Upper Brush Creek Canyon at the base of Kaler Hollow in SESWSE 29-1S-21E at an elevation of 8,180 feet (2493m). A short foot-path, 1 3/4 miles (2.8 km),past the Iron Springs campgrounds, leads into the box canyon and to the mine workings. Two smaller adits are located farther upstream. Exploratory work has been minor and achieved little success, but a little lead-silver ore was shipped. The mine is developed along fractured dark-gray cherty limestone of Mississippian age. Ore follows replaced limestone beds along a joint plane. Most of the workings in the mine area are open. The cave opening is very large, approximately 100 feet (30.5m) in height and width, but little work has been done in the cave itself, no ore is visible. Of the two adits upstream, only one is open and it is short. Ore minerals include galena and a lead carbonate, none remains on the dumps or in the workings. The reserve potential is minor.

Other Prospects

In the south half of section 13 and the north half of section 24-1S-21E along Little Brush Creek are several lead prospects that lie on the crest of a southeast plunging anticlinal nose. There are four patented claims, which in 1907 had workings including a 135-foot tunnel and drifts totaling 111 feet. Production or ore potential is unknown. The workings are also in Mississippian limestone beds.

References:

Butler, B. S. and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, p. 599-606.

Heyl, A. V., 1963, Oxidized zinc deposits of the United States, Pt. 2, Utah: U. S. Geol. Survey Bull. 1135-B, p. B52-53.

Kinney, D. M., 1955, Geology of Uinta River-Brush Creek area, Duchesne and Uintah Counties, Utah: U. S. Geol. Survey Bull. 1007, 185p.

Pruitt, R. G., 1961, Mineral Resources of Uintah Co., Utah: Utah Geol. and Mineral Survey Bull. 71, p. 88-90.

UTAH COUNTY

Utah County, in north-central Utah, has produced important amounts of lead and zinc. One mine continues to yield large amounts of the two metals as well as silver (1976). Recorded production of lead, through 1975, stands at 566,106 tons valued at almost $92,000,000 and that for zinc stands at 141,057 tons valued at $57,300,000. Utah County has two important districts which have produced lead and zinc; American Fork and East Tintic. The latter district is active, has produced the most and has the greatest potential for the future production of lead and zinc. The county and the two districts are located in figure 190 and the production is summarized in table 49. Utah County has several other lead and zinc districts, but their combined production has been very small. These districts include Alpine, Provo, Spanish Fork, and Santaquin.

American Fork District

The American Fork mining district is located in the northern part of the county and its center is in the upper end of the left hand fork of American Fork Canyon and Mary Ellen Gulch. The district is 22 miles (35.4 km) southeast of Salt Lake City and 16 miles (25.7km) northeast of the town of American Fork (figure 191). The district was organized in 1870 and a large number of claims were filed in 1871. The Miller mine became the principal producer and mined sufficient ore to require the construction of the Sultana smelter in 1872. Production between 1870 and 1880 was estimated at 39,950 tons having a value of over $2,600,000 (Calkins and Butler, 1943, p. 86). Thereafter activity became more modest and for 80 years the value of production fluctuated from $23,000 to $903,000 per decade. The total lead production from the district amounts to 18,197 tons of lead and 2,771 tons of zinc. The last production from the district occurred in 1963. The district's production is summarized in table 50.

Geologic formations exposed in the district range in age from Precambrian

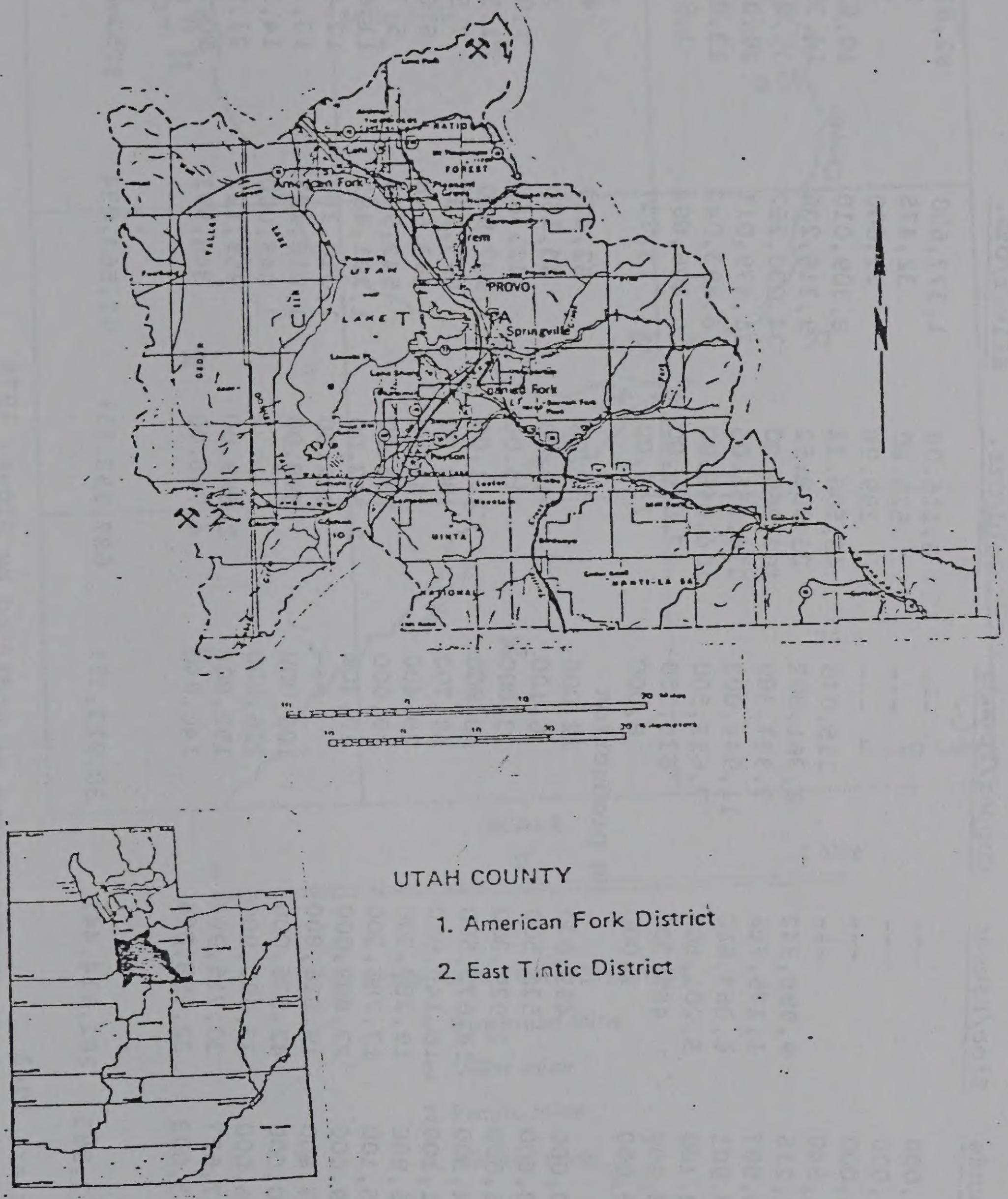
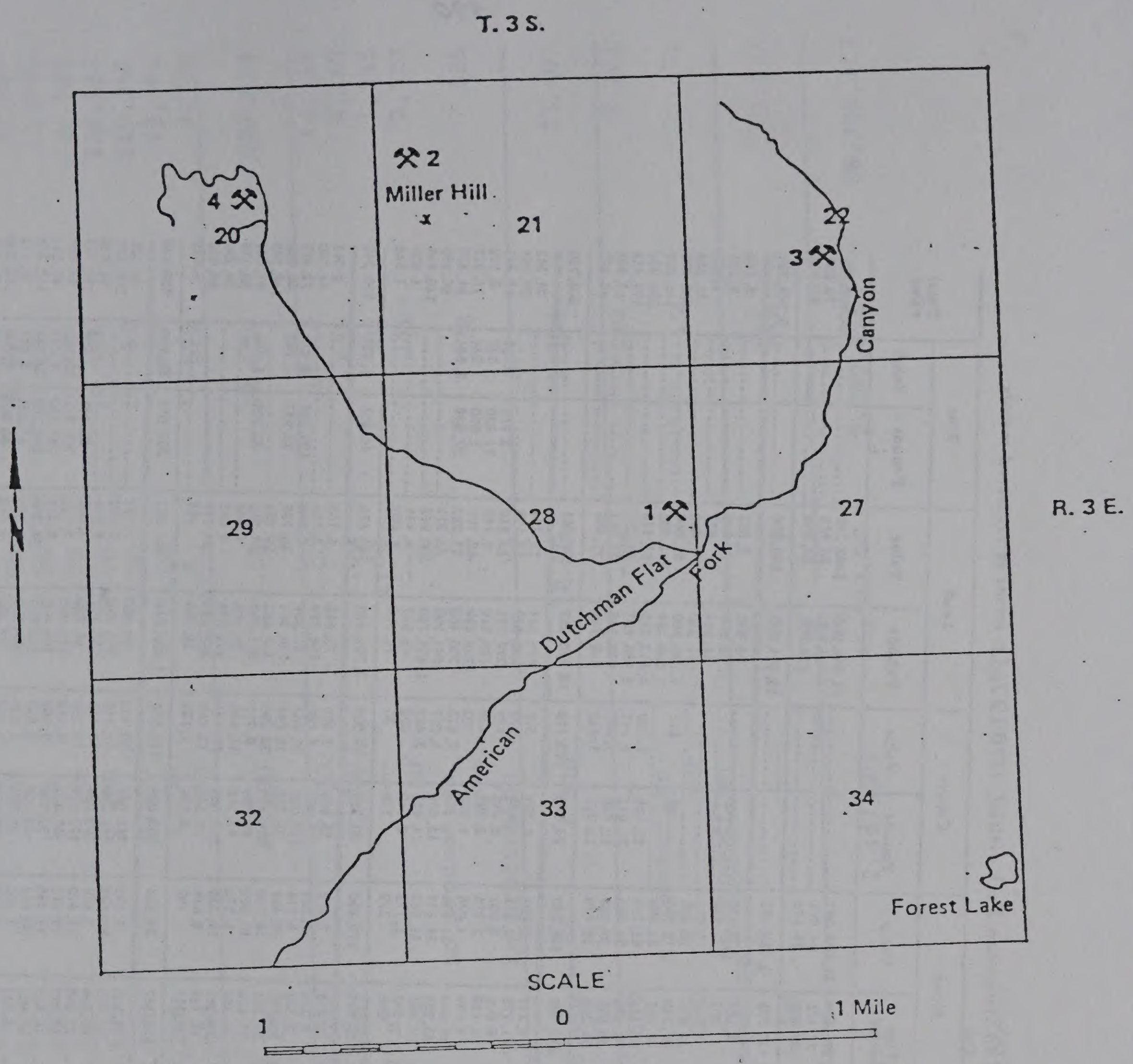


Figure 190: Location map of Utah County and its lead-zinc mining districts.

Table 49: Production of metals from Utah County, 1870-1975

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1870-1880	39,950	14,868,000	---	---	3,116.08	1,377,600	$2,630,701
1881-1890	990	693,000	---	---	526.80	32,475	75,366
1891-1900	1,000	510,000	---	---	199.98	22,000	37,665
1901-1910	236,869	122,361,840	---	115,046	43,504.32	8,309,010	10,810,141
1911-1920	405,831	67,451,215	9,998,342	2,361,802	23,908.52	9,318,236	14,364,370
1921-1930	1,695,225	434,403,597	1,175,786	7,337,389	167,960.80	34,030,282	56,270,235
1931-1940	1,266,675	144,247,901	6,063,820	11,944,003	314,256.05	21,479,011	29,095,786
1941-1950	826,864	58,232,100	5,201,800	7,652,500	104,848.00	6,493,043	13,809,339
1951-1960	167,370	5,028,400	482,300	618,500	7,076.00	806,094	1,948,357
1961	4,717	8,000	2,000	6,000	117.00	4,737	11,170
1962	?			no production			
1963	?	3,170,000	492,000	12,000	72.00	82,427	498,880
1964	?	1,700,800	526,500	6,100	40.00	43,160	359,629
1965	?	7,056,900	2,929,300	3,000	43.00	342,368	1,920,269
1966	?	45,684,300	14,673,500	40,800	111.00	1,937,980	11,572,237
1967	?	29,771,100	16,148,900	50,700	80.00	893,137	7,585,150
1968	?	18,896,900	19,287,300	29,400	41.00	693,648	6,657,067
1969	?	14,465,100	17,786,300	59,000	735.00	542,944	5,782,198
1970	?	31,869,000	27,889,000	19,400	2,312.00	1,291,482	11,660,485
1971	?	24,477,800	19,826,800	---	591.00	1,010,287	12,446,736
1972	?	34,350,000	42,526,000	102,000	398.00	1,018,127	13,704,510
1973	?	27,466,000	33,600,000	226,000	?	1,045,000	14,259,100+
1974	161,544	25,837,627	30,715,968	192,808	2,869.00	959,122	21,587,854
1975	32,728+	19,663,003	32,788,825	146,943	4,748.00	848,991	20,814,583
Totals:		1,132,212,583	282,114,441	30,923,391	687,553.55+	92,563,034	$257,901,828

1870-1904: Calkins and Butler, 1943
1905-1973: U. S. Bur. Mines Mineral Yearbooks except as modified by Stowe, 1975
1974-1975: Utah State Tax Commission



AMERICAN FORK DISTRICT

1. Dutchman mine
2. Miller mine
3. Pacific mine
4. Yankee mine

Figure 191: Outline map of the American Fork Mining District

Adapted From: USGS Dromedary Peak 7½′ Quadrangle
USGS Brighton 7½′ Quadrangle

Table 50:

Gold, silver, copper, lead, and zinc produced in American Fork district, 1870-1976in terms of recovered metals

Period	Number of mines	Ore mined (tons)	Gold		Silver		Copper		Lead		Zinc		Total value
			Fine ounces	Value	Fine ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
1870-80		39,950	3,118.08	$64,415	1,377,600	$1,683,542			14,868,000	$882,744			$2,630,701
1881-90		990	524.80	10,890	32,475	34,071			693,000	30,405			75,366
1891-1900		1,000	199.98	4,134	22,000	15,876			510,000	17,655			37,665
		41,940	3,842.86	79,439	1,432,075	1,733,489			16,071,000	930,804			2,743,732
1901	2	128	35.41	732	3,608	2,111			76,800	3,302			6,145
1902	1	39	3.53	73	663	351			23,000	970			1,394
1903	2	64	21.28	440	1,872	1,011			11,214	471			1,922
1904	3	922	799.18	16,537	18,890	10,809			617,280	27,000			54,352
1905	4	2,479	1,301.00	26,894	27,740	16,765	88	$14	1,374,600	64,609			108,272
1906	5	2,914	2,096.81	43,345	47,611	31,809			1,950,784	111,708			186,952
1907	4	4,706	3,483.82	72,017	93,551	61,744	45,098	9,020	3,012,785	191,478			334,259
1908	4	2,358	745.51	15,411	64,840	34,306	20,073	2,442	1,380,896	58,237			111,455
1909	7	1,025	125.15	2,587	39,821	20,707	10,670	1,887	628,148	27,011			51,692
1910	5	965	183.10	3,785	34,204	18,470	12,227	1,653	519,749	22,869			46,677
1901-10		15,608	8,795.60	181,821	332,800	198,222	94,166	15,416	10,210,682	507,661			903,120
1911	6	494	79.05	1,634	9,441	5,004	4,092	511	386,644	17,394			24,543
1912	6	659	121.42	2,510	11,172	6,871	3,466	572	380,630	17,128			27,081
1913	8	411	30.57	632	6,609	3,991	2,949	457	279,772	12,310	2,712	$152	17,542
1914	7	224	68.93	1,425	4,189	2,316	3,591	478	106,219	4,143	14,830	757	9,119
1915	9	413	49.01	1,013	8,039	4,076	4,018	703	259,459	12,196	2,050	254	18,242
1916	6	868	43.30	895	48,360	31,821	31,189	7,673	250,460	17,282	27,319	3,661	61,332
1917	7	3,610	96.94	2,004	35,021	28,857	15,630	4,207	641,990	55,211			90,339
1918	6	11,876	46.49	961	34,805	34,865	14,951	3,693	1,421,790	100,947			140,468
1919	4	116	45.18	934	1,583	1,773	3,649	679	45,917	2,434			5,820
1920	3	49	.53	11	296	322	179	33	18,019	1,490			1,856
1911-20		18,719	581.42	12,019	159,515	119,896	83,714	19,006	3,791,440	240,535	46,911	4,824	396,340
1921	3	255	198.39	4,101	1,813	1,813	15,314	1,976	25,618	1,153			9,043
1922	5	539	335.05	6,926	7,300	7,306	31,081	4,196	104,629	5,765			24,183
1923	3	1,860	1,493.19	30,867	7,583	6,218	142,052	20,881	91,259	6,388	120,854	8,218	72,572
1924	7	1,961	534.30	11,045	15,528	10,404	76,070	10,044	378,342	30,267	72,957	4,742	66,502
1925	6	3,374	3,204.17	66,236	27,555	19,130	234,495	33,298	339,433	29,531			148,195
1926	7	3,466	1,379.56	28,518	17,455	10,892	69,794	9,771	337,619	27,010	73,204	5,490	81,681
1927	5	1,190	1,558.11	32,209	9,207	5,220	87,369	11,446	20,706	1,304			50,179
1928	3	4,676	3,007.76	62,176	19,381	11,338	116,089	16,717	139,016	8,063			98,294
1929	3	5,737	1,657.81	34,270	18,458	9,838	70,863	12,419	383,032	24,131			80,658
1930	2	252	118.32	2,446	1,291	497	8,639	1,123	19,260	963			5,029
1921-30		23,310	13,486.66	278,794	125,597	82,656	852,066	121,871	1,838,914	134,565	267,015	18,450	636,336
1931	2	5,671	3,207.99	66,315	17,836	5,172	247,007	22,478	69,500	2,572			96,537
1932	2	21,617	7,145.47	147,710	58,826	16,589	545,380	34,359	263,120	7,893			206,551
1933	3	7,169	2,497.30	63,831	22,509	7,878	195,024	12,481	185,117	6,849			91,039
1934	8	6,929	2,906.98	101,599	27,086	17,510	177,112	14,169	81,270	3,007	21,531	928	137,213
1935	8	3,059	776.40	27,174	17,273	12,415	58,337	4,842	179,900	7,196	296,841	13,061	64,688
1936	7	1,680	400.40	14,014	18,652	14,446	32,272	2,969	183,500	8,441	143,480	7,174	47,044
1937	9	5,243	639.00	22,365	38,861	30,059	63,000	7,623	582,000	34,338	368,200	23,933	118,318
1938	5	1,110	268.00	9,380	6,551	4,235	18,765	1,839	164,739	7,578	85,021	4,081	27,113
1939	7	570	177.00	6,195	3,109	2,151	16,923	1,760	32,766	1,540	30,000	1,560	13,208
1940	8	4,268	69.00	2,415	32,317	22,981	15,640	1,768	552,100	27,605	513,286	32,337	87,106
1931-40		57,316	18,087.54	460,998	243,080	133,436	1,369,466	104,288	2,204,012	107,019	1,468,409	83,074	888,815

Table 50 continued:

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1941	2,128	246,300	452,000	14,000	51.00	21,119	$66,394
1942	596	52,400	108,700	1,200	5.00	3,787	16,633
1943	429	24,000	25,500	2,100	7.00	1,779	6,337
1944	1,016	102,600	235,500	1,000	8.00	5,061	39,069
1945	333,	45,000	41,600	1,000	8.00	2,970	11,181
1946	2,773	418,000	658,500	7,000	56.00	14,245	140,503
1947	3,305	589,000	944,600	9,400	34.00	19,768	220,167
1948	2,849	437,600	918,700	6,900	31.00	16,852	218,351
1949	1,058	158,200	343,200	3,000	10.00	7,919	75,661
1950	94	18,600	10,400	500	1.00	675	4,738
1941-1950	14,581	2,091,700	3,738,700	46,100	211.00	94,175	799,034
1951	544	47,400	21,600	2,000	16.00	1,948	14,938
1952	69	16,000	5,000	200	1.00	695	4,118
1953	15	5,400	2,000	---	1.00	302	1,245
1954	45	15,900	---	100	---	341	2,517
1955				no production			
1956	12	3,300	518	---	---	78	589
1957-1960				no production			
1951-1960	685	88,000	29,118	2,300	18.00	3,364	23,407
1961	?	8,100	2,100	---	---	130	1,261
1962				no production			
1963	?	300	200	---	---	15	72
1964-1976				no production			
1961-1976	?	8,400	2,300	---	---	145	1,333
Totals:	172,149+ (Incomplete)	36,394,148	5,542,453	2,447,802	45,023.07	2,390,691	$6,392,117

1870-1940: Calkins and Butler, 1943, p. 86
1941-1963: U. S. Bur. Mines Mineral Yearbooks

quartzites, sandstones and shales to Mississippian limestones (figure 192). Igneous rocks consist of dikes originating in the quartz monzonite and granodiorite stocks to the north and northwest. The structure is complex with folds, normal faults and thrust faults. The normal faults are the most important structural features in the district, the east-west trending Miller Hill and Dutchman faults and the north-south trending Silver Fork fault are the most prominent. Thrust faults occur in the northern and southwestern parts of the district. Ore bodies occur as replacements in carbonate rocks and in fissure veins. The largest production has been from replacement ore bodies in the limestone beds of the Ophir Shale, Gardison and Maxfield Limestones. The ore occurs at the intersections of fissures and the favorable limestone beds forming tabular bedded deposits. Fissure vein deposits are found as fracture fillings in both quartzites and limestones. The bedded replacement deposits have been far more important than the fissure deposits with respect to ore. Most of the mine workings are caved at the portals making it difficult to determine what reserves may remain in the individual mines. The district's ore potential is based on geologic inference and is thought to be good.

Dutchman Mine

The Dutchman mine is located on the north side of Dutchman Flat in unsurveyed NE28-3S-3E at an elevation of 7,720 feet (2353m). The Dutchman, formerly called the Wild Dutchman, was located in 1872 and was sold to the Omaha Smelting and Refining Co. soon after. The company worked the mine until September 1876 and produced several thousand tons of ore. After that time the mine was worked intermittently by various lessees. In 1917 ore was milled by a 100-ton concentrator erected at the portal of the mine. From 1901-1916, 2,492 tons of ore were mined averaging $0.89 in gold, 47.58 ounces in silver and 27.89 percent lead (Calkins and Butler, 1943, p. 137). Lessees worked in the lower tunnel in 1936, 1939 and 1942 and in 1939 and 1942

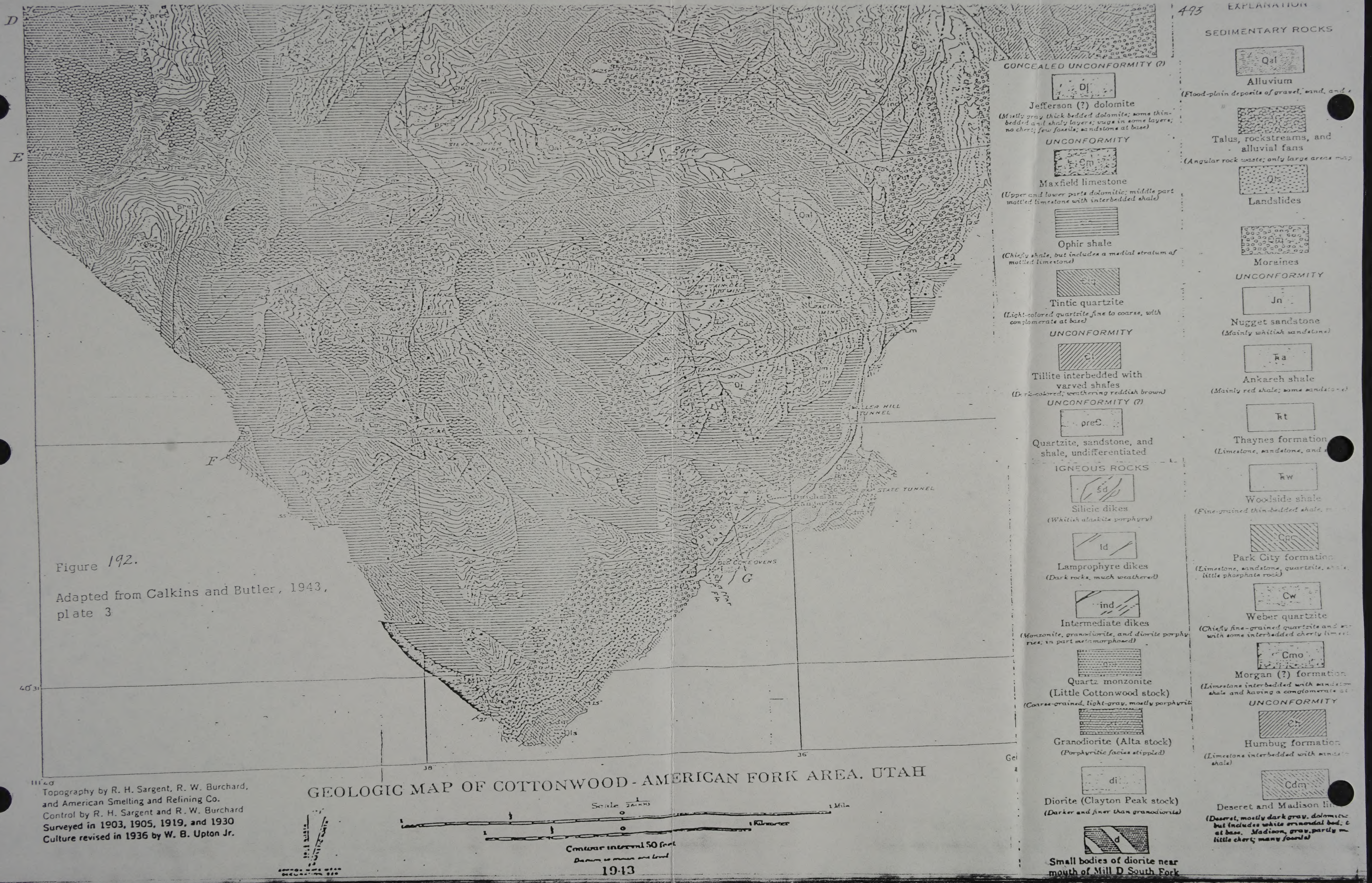


Figure 192.

Adapted from Calkins and Butler, 1943, plate 3

D
E
F
G
GEOLOGIC MAP OF COTTONWOOD - AMERICAN FORK AREA, UTAH
Topography by R. H. Sargent, R. W. Burchard, and American Smelting and Refining Co.
Control by R. H. Sargent and R. W. Burchard
Surveyed in 1903, 1905, 1919, and 1930
Culture revised in 1936 by W. B. Upton Jr.
Scale
1 Mile
1 Kilometer
Contour interval 50 feet
1943
STATE TUNNEL
TUNNEL
Qal
Dj
38
36
40°31
111°40
CONCEALED UNCONFORMITY (?)
Dj
Jefferson (?) dolomite
(Mostly gray thick-bedded dolomite; some thin-bedded and shaly layers; vugs in some layers; no chert; few fossils; sandstone at base)
UNCONFORMITY
Cm
Maxfield limestone
(Upper and lower parts dolomitic; middle part mottled limestone with interbedded shale)
Ophir shale
(Chiefly shale, but includes a medial stratum of mottled limestone)
Tintic quartzite
(Light-colored quartzite fine to coarse, with conglomerate at base)
UNCONFORMITY
Tillite interbedded with varved shales
(Dark-colored, weathering reddish brown)
UNCONFORMITY (?)
preC
Quartzite, sandstone, and shale, undifferentiated
IGNEOUS ROCKS
sd
Silicic dikes
(Whitish alaskite porphyry)
ld
Lamprophyre dikes
(Dark rocks, much weathered)
ind
Intermediate dikes
(Monzonite, granodiorite, and diorite porphyries; in part metamorphosed)
Quartz monzonite
(Little Cottonwood stock)
(Coarse-grained, light-gray, mostly porphyriti
Granodiorite (Alta stock)
(Porphyritic facies stippled)
di
Diorite (Clayton Peak stock)
(Darker and finer than granodiorite)
d
Small bodies of diorite near mouth of Mill D South Fork
EXPLANATION
SEDIMENTARY ROCKS
Qal
Alluvium
(Flood-plain deposits of gravel, sand, and
Talus, rockstreams, and alluvial fans
(Angular rock waste; only large areas
Qls
Landslides
Moreines
UNCONFORMITY
Jn
Nugget sandstone
(Mainly whitish sandstone)
Ra
Ankareh shale
(Mainly red shale; some sandstone)
Rt
Thaynes formation
(Limestone, sandstone, and
Rw
Woodside shale
(Fine-grained thin-bedded shale,
Cpc
Park City formation
(Limestone, sandstone, quartzite, shale, little phosphate rock)
Cw
Weber quartzite
(Chiefly fine-grained quartzite and with some interbedded cherty lim
Cmo
Morgan (?) formation
(Limestone interbedded with sandstone shale and having a conglomerate at
UNCONFORMITY
Ch
Humbug formation
(Limestone interbedded with sandst shale)
Cdm
Deseret and Madison li
(Deseret, mostly dark gray, dolomit but includes white crinoidal bed; at base. Madison, gray, partly little chert; many fossils)

ore rich in galena and sphalerite were mined from below the lower tunnel. The mine output through 1917 amounted to 10,392 tons. The mine workings are extensive and in 1880 were in excess of 20,000 feet (6096m)(figure 193).

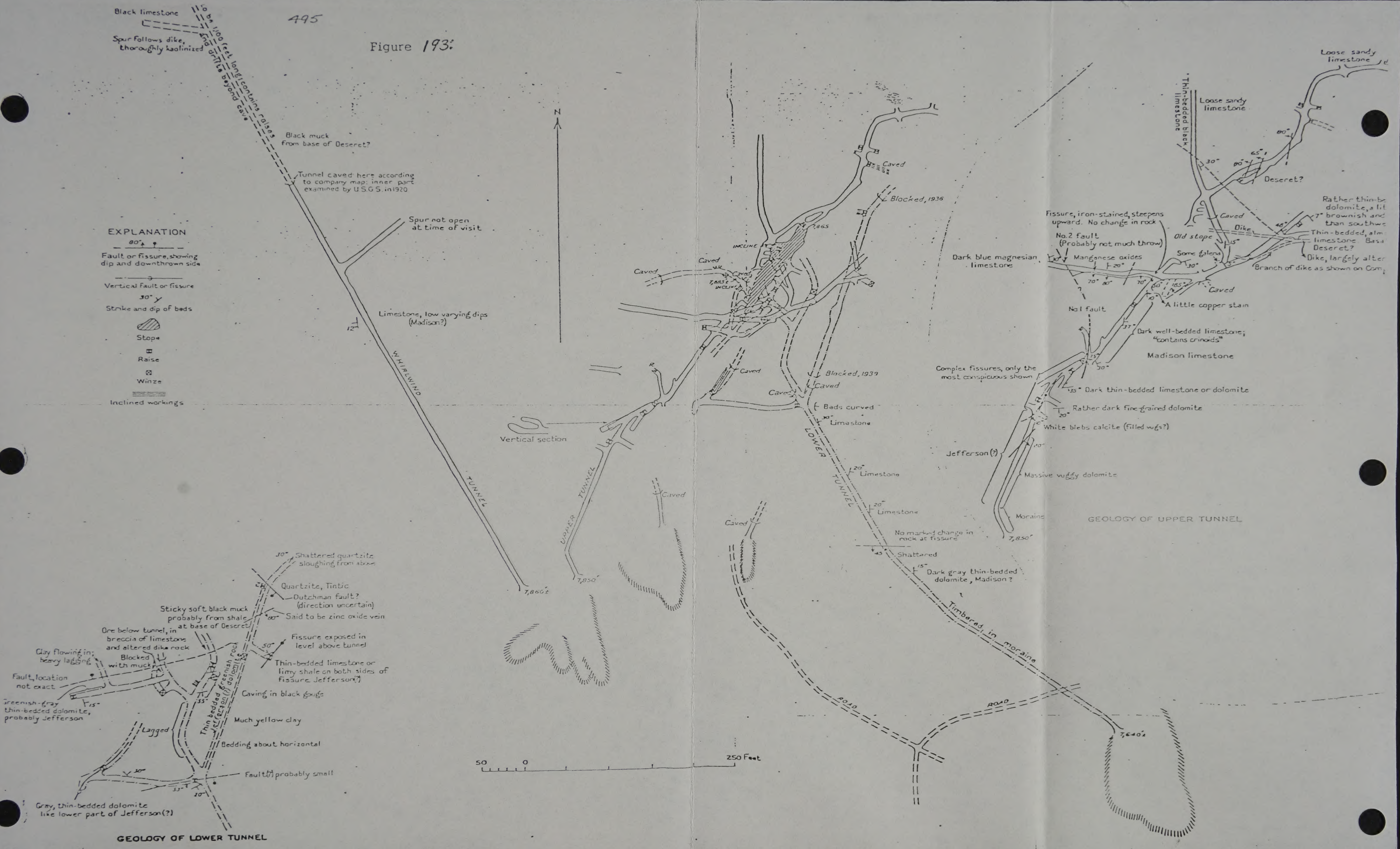
The product of the mine has mainly been lead-silver ore, although zinc is relatively abundant in the lower workings. The principal vein in the mine strikes N. 40° E. and dips steeply to the southeast and ranges in width from a seamlet to 8 feet (2.4m). The vein is in a dark-blue limestone and lies along a narrow porphyry dike. The ore bodies are in Devonian and Mississippian limestones which are bounded on the north and west by the Dutchman and Whirlwind faults. Minerals in the mine are cerussite, smithsonite, galena, sphalerite, azurite, barite, pyrite and quartz. There are no known reserves in the mine.

Miller Mine

The Miller mine is located near the top of Miller Hill between Mineral Basin and Mary Ellen Gulch. The mine is in unsurveyed NW 21-3S-3E at an elevation of 9,770 feet. The property was staked in 1871 by Jacob and William Miller of Alta and by 1872 was the most important mine of the district. The Sultana furnace was completed in 1972 to handle the ore and several hundred tons were smelted. In 1873, the Wyoming mine, part of the Miller Group, was developed by two tunnels. By December, 1876 the rich ore bodies were exhausted and the mine was closed after producing more than a million dollars worth of ore. Lessees subsequently mined lower grade ore from the old workings. In 1904 development work by lessees revealed considerable lead-carbonate ore. The rich ore was sacked and slid down to Dutchman Flat on the snow, and then hauled by teams down the old railroad grade to American Fork. In 1908 little ore remained, the stopes ending against a fault. In the four years nearly 12,000 tons of ore were produced worth $600,000.

The main ore body in the mine was formed as a replacement of highly shattered beds of Maxfield Limestone. Ore shoots followed the intersections of these beds and fissures striking east (Calkins and Butler, 1943, p. 140).

Figure 193.


Black limestone
Spur follows dike, thoroughly kaolinized
1100 feet long; contains raises and drifts beyond cave
Black muck from base of Deseret?
Tunnel caved here according to company map; inner part examined by U.S.G.S. in 1920
Spur not open at time of visit
Limestone, low varying dips (Madison?)
12°
WHIRLWIND TUNNEL
7,860'±
EXPLANATION
80°
Fault or fissure, showing dip and downthrown side
Vertical fault or fissure
30°
Strike and dip of beds
Stope
Raise
Winze
Inclined workings
N
Vertical section
UPPER TUNNEL
7,850'
Caved
INCLINE
7,865
7,885'±
Blocked, 1936
Blocked, 1939
Beds curved
Limestone
LOWER TUNNEL
20°
No marked change in rock at fissure
Shattered
45
15°
Dark gray thin-bedded dolomite, Madison ?
Timbered in moraine
ROAD
7,640'±
50
0
250 Feet
Thin-bedded black limestone
Loose sandy limestone
30°
80°
65°
Deseret?
Rather thin-be dolomite, a lit brownish and than southwe
Thin-bedded, alm limestone. Basa Deseret?
Dike, largely alter
Branch of dike as shown on Com
Dike
48°
Old stope
Some galena
Fissure, iron-stained, steepens upward. No change in rock
No. 2 fault (Probably not much throw)
Dark blue magnesian limestone
Manganese oxides
70°
No 1 fault
A little copper stain
37°
Dark well-bedded limestone; "contains crinoids"
Madison limestone
75°
Complex fissures, only the most conspicuous shown
25° Dark thin-bedded limestone or dolomite
Rather dark fine-grained dolomite
White blebs calcite (filled vugs?)
10°
Jefferson (?)
Massive vuggy dolomite
Moraine
GEOLOGY OF UPPER TUNNEL
Shattered quartzite sloughing from above
Quartzite, Tintic
Dutchman fault? (direction uncertain)
Said to be zinc oxide vein
Sticky soft black muck probably from shale at base of Deseret
Ore below tunnel, in breccia of limestone and altered dike rock
Fissure exposed in level above tunnel
50°
Thin-bedded limestone or limy shale on both sides of fissure. Jefferson(?)
Clay flowing in; heavy lagging
Blocked with muck
Fault, location not exact
Greenish-gray thin-bedded dolomite, probably Jefferson
Thin bedded greenish rock Jefferson(?) dolomite
Caving in black gouge
55°
Much yellow clay
Lagged
Bedding about horizontal
Fault(?) probably small
33°
Gray, thin-bedded dolomite like lower part of Jefferson(?)
GEOLOGY OF LOWER TUNNEL

WORKINGS OF DUTCHMAN MINE

Minerals in the ore are cerussite, smithsonite, galena, sphalerite, argentite, malachite, azurite, plumbojarosite, wulfenite, wad, limonite, pyrite, barite and quartz. No known reserves remain in the mine.

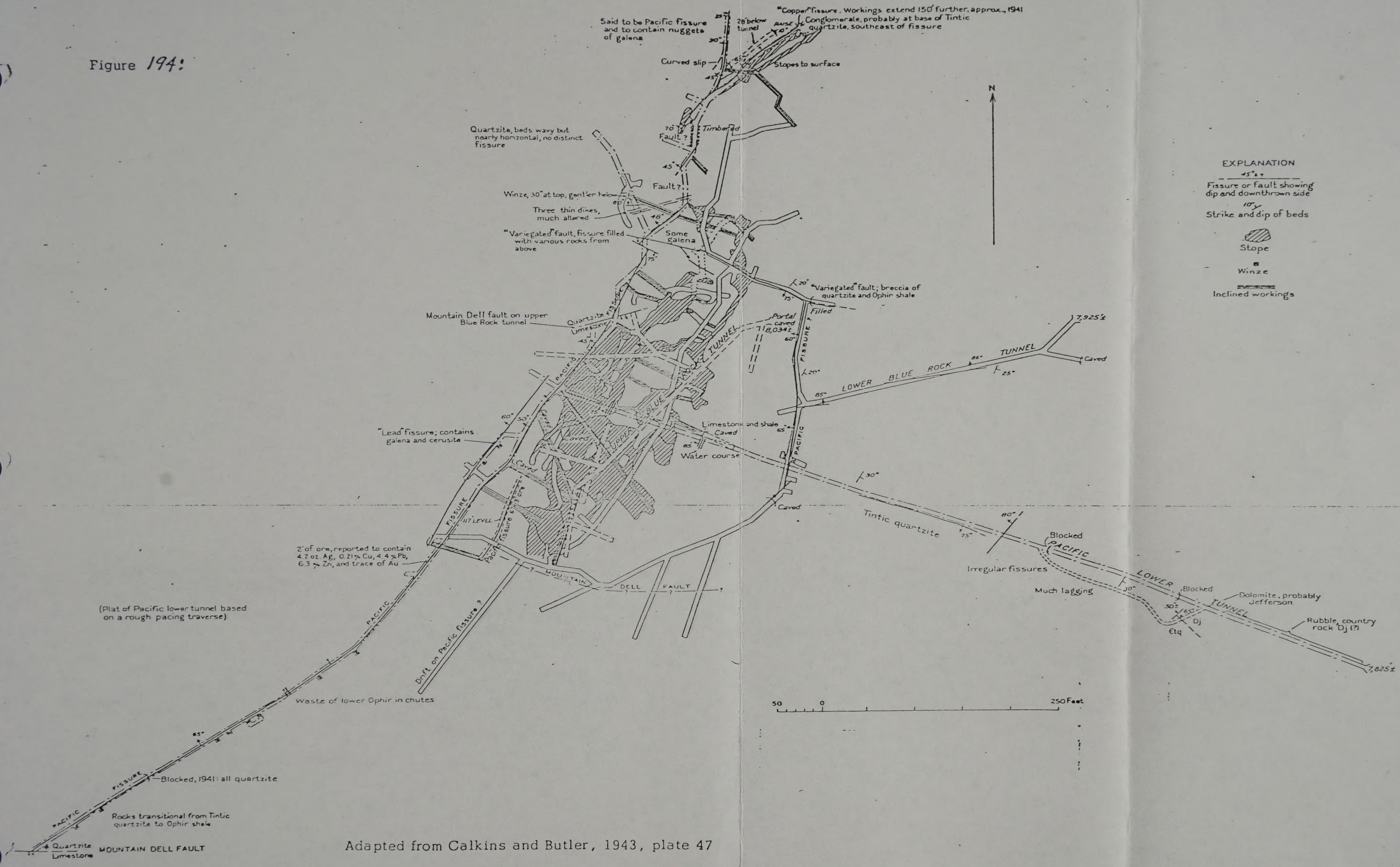
Pacific Mine

The Pacific, or Blue Rock mine, as it is sometimes known, is on the west side of the Left Fork of American Fork Canyon, just past the intersection of Dry Fork Trail and Mineral Basin road. The mine portal is in unsurveyed SW 22-3S-3E at an elevation of 7,800 feet (2377m). The property consists of 6 claims that were located prior to 1905, active development work continued for several years thereafter under the management of Pacific Gold Mining and Milling Co. Small lots of lead-silver ore were shipped in 1907 and in 1909 averaging 30 ounces silver and 15 percent lead. In 1913 some ore on the dump was concentrated by jigs by a lessee. Fissures Exploration Co. leased the mine and hauled ore to a concentrator located at the portal of the Dutchman mine. In 1917, the concentrator was dismantled and moved to the Pacific mine where it was reassembled and increased in size to treat 150 tons per day. It operated for a short time and was closed December 11, 1919. In 1929 the mill was remodeled to treat ore mined from the Pacific fissure and lessees were working in the mine in 1936 (Calkins and Butler, 1943, p. 135).

The ore bodies in the mine are in fissures along east-west faults. These faults bring the Mississippian Madison Limestone south of the fault against Cambrian Tintic Quartzite on the north (figure 194). Most of the workings are in the Tintic Quartzite and Ophir Shale. The Pacific and Copper fissures are the two most important in the mine. Mineralization in the Pacific occurs in shoots having a southwesterly pitch and lie in the Tintic Quartzite close to the overlying Ophir Shale. Minerals in the ore are galena, sphalerite, tetrahedrite, and their oxidation products. Gangue minerals are pyrite, quartz and barite. No reserves remain in the mine.

497

Figure 194:


"Copper" fissure. Workings extend 150' further, approx., 1941
Said to be Pacific fissure and to contain nuggets of galena
28' below tunnel
Raise
Conglomerate, probably at base of Tintic quartzite, southeast of fissure
Curved slip
Stopes to surface
Timbered
Fault ?
Quartzite, beds wavy but nearly horizontal, no distinct fissure
Fault?
Winze, 30° at top, gentler below
Three thin dikes, much altered
"Variegated" fault, fissure filled with various rocks from above
Some galena
"Variegated" fault; breccia of quartzite and Ophir shale
Filled
Portal caved 8,034±
Mountain Dell fault on upper Blue Rock tunnel
Quartzite
Limestone
PACIFIC FISSURE
UPPER BLUE TUNNEL
LOWER BLUE ROCK TUNNEL
7,925±
Caved
"Lead" fissure; contains galena and cerusite
Limestone and shale
Caved
Water course
Caved
117' LEVEL
Pacific fissure 6' 3" ore
2' of ore, reported to contain 4.2 oz. Ag, 0.21% Cu, 4.4% Pb, 6.3% Zn, and trace of Au
MOUNTAIN DELL FAULT
Tintic quartzite
Blocked
Irregular fissures
Much lagging
PACIFIC LOWER TUNNEL
Blocked
Dolomite, probably Jefferson
Rubble, country rock Dj (?)
Dj
Ꞓtq
7,825±
(Plat of Pacific lower tunnel based on a rough pacing traverse)
Drift on Pacific fissure ?
Waste of lower Ophir in chutes
Blocked, 1941: all quartzite
Rocks transitional from Tintic quartzite to Ophir shale
Quartzite
Limestone
MOUNTAIN DELL FAULT
N
50
0
250 Feet
EXPLANATION
45°
Fissure or fault showing dip and downthrown side
10°
Strike and dip of beds
Stope
Winze
Inclined workings

Adapted from Calkins and Butler, 1943, plate 47

WORKINGS OF PACIFIC MINE

Yankee Consolidated Mine

The Yankee mine is located in Mary Ellen Gulch in unsurveyed NW 20-3S-3E at an elevation of 9,120 feet (2780m). The Yankee mine is a consolidation of the Live Yankee, Belorophan and several other claims. In 1880 the Belorophan mine was opened by three tunnels over 600 feet (183m) long and the Live Yankee, Mary Ellen and West Extension claims had 1,600 feet (488m) of development. All of these properties were operating and yielding some ore in 1919. A small concentrating mill was opened at the Belorophan claim in 1918 and ore was treated. Lessees occasionally operated the Live Yankee and in 1919 it was operated jointly with the Belorophan by the American Leasing Co. Between 1911 and 1919 the Live Yankee and Belorophan produced 750 tons of ore. From 1921-1937 the Live Yankee and Belorophan were developed by the American Smelting and Refining Co. (Calkins and Butler, 1943, p. 143). The U. S. Bur. of Mines Mineral Yearbooks indicate activity at the Yankee Consolidated mine extended into the 1960s.

Sedimentary rock found in the mines are the Tintic Quartzite, Ophir Shale, and Maxfield Limestone. These rocks are cut by a thick east-west dike of granodiorite porphyry and by a thinner northeast striking dike. The structure in the area of the mines is extremely complex with numerous faults cutting the area (figure 195). Ore in the area can be classified into placer ore, breccia ore and fissure ore. Boulders and pebbles ranging from a fraction of an ounce to hundreds of pounds were found in the gulch west of the Yankee mine. Considerable production was achieved by sorting and washing boulders and pebbles from this placer. In the upper levels of the Yankee mine is a wide breccia zone along the Live Yankee fault. Within this zone ore has been mined which was valuable for its lead, silver, copper, and gold. The fissure ore is derived from the Belorophan fissure in the Tintic Quartzite where a vein ranging from 1 to 20 feet (0.3-6m) wide occurs. The minerals in the vein are galena, sphalerite, tetrahedrite, barite and quartz. There are no reserves remaining

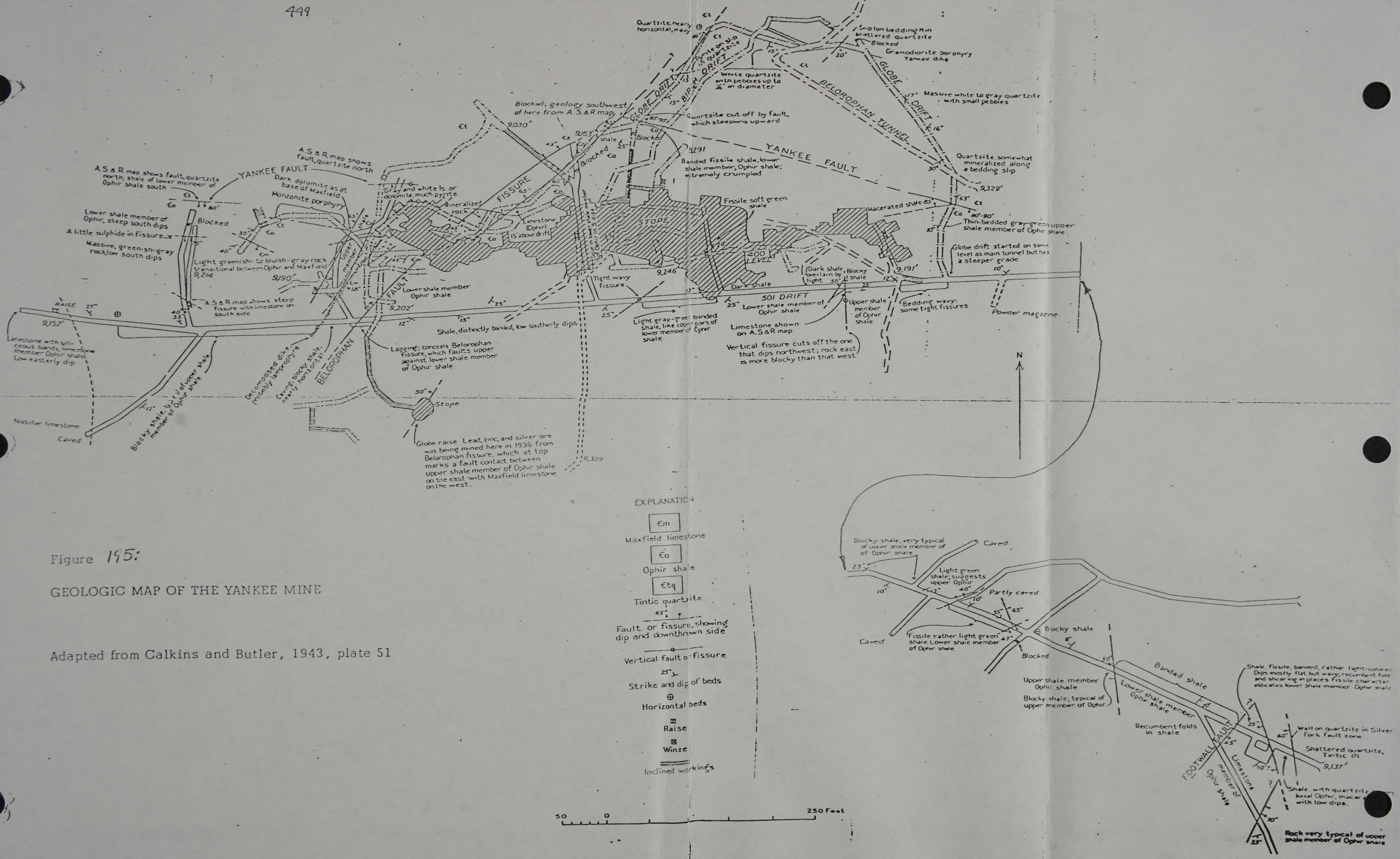

A.S.& R map shows fault, quartzite north; shale of lower member of Ophir shale south
YANKEE FAULT
A.S.& R map shows fault, quartzite north
Dark dolomite as at base of Maxfield
Monzonite porphyry
Gray and white ls. or dolomite, much pyrite
Mineralized rock
FISSURE
Lower shale member of Ophir, steep south dips
Blocked
A little sulphide in fissure
Massive, greenish-gray rock low south dips
Light greenish- to bluish-gray rock transitional between Ophir and Maxfield
9,214
9,190'
Upper member
FAULT
Lower shale member Ophir shale
9,202'
A.S.& R map shows steep fissure with limestone on south side
RAISE
9,152'
Limestone with siliceous bands, limestone member Ophir shale, Low easterly dip
Nodular limestone
Caved
Blocky shale, typical of upper shale member of Ophir shale
Decomposed dike, probably lamprophyre
Caving; blocky shale, nearly horizontal
BELOROPHAN
Lagging; conceals Belorophan fissure, which faults upper against lower shale member of Ophir shale
Stope
Globe raise Lead, zinc, and silver ore was being mined here in 1936 from Belorophan fissure, which at top marks a fault contact between upper shale member of Ophir shale on the east with Maxfield limestone on the west.
9,329
Shale, distinctly banded, low southerly dips
Limestone (Ophir) 15' above drift
Blocked; geology southwest of here from A.S.& R. map
9,030'
9,163'
Blocked
Quartzite nearly horizontal, wavy
GLOBE DRIFT
BIRCH DRIFT
White quartzite with pebbles up to ¼" in diameter
Quartzite cut off by fault, which steepens upward
9291
Banded fissile shale, lower shale member, Ophir shale; extremely crumpled
Fissile soft green shale
STOPE
400 LEVEL
9,246
Tight wavy fissure
Light gray-green banded shale, like upper part of lower member of Ophir shale
501 DRIFT
Dark shale
Dark shale overlain by light
Blocky shale
Lower shale member of Ophir shale
Upper shale member of Ophir shale
Limestone shown on A.S.& R map
Vertical fissure cuts off the one that dips northwest; rock east is more blocky than that west
Slip on bedding in shattered quartzite
Blocked
Granodiorite porphyry Yankee dike
BELOROPHAN TUNNEL
GLOBE DRIFT
Massive white to gray quartzite with small pebbles
Quartzite somewhat mineralized along a bedding slip
9,329'
Macerated shale
Thin-bedded gray-green upper shale member of Ophir shale
Globe drift started on same level as main tunnel but has a steeper grade
9,191'
Bedding wavy; some tight fissures
Powder magazine
N
Blocky shale, very typical of upper shale member of of Ophir shale
Caved
Light green shale; suggests upper Ophir
Partly caved
Caved
Fissile rather light green shale Lower shale member of Ophir shale
Blocky shale
Blocked
Upper shale member Ophir shale
Blocky shale, typical of upper member of Ophir
Banded shale
Lower shale member Ophir shale
Recumbent folds in shale
FOOTWALL FAULT
Limestone member of Ophir shale
Shale, fissile, banded, rather light-colored Dips mostly flat but wavy; recumbent fold and shearing in places Fissile character indicates lower shale member Ophir shale
Wall on quartzite in Silver Fork fault zone
Shattered quartzite, Tintic (?)
9,137'
Shale, with quartzite basal Ophir, macer with low dips.
Rock very typical of upper shale member of Ophir shale
EXPLANATION
Єm
Maxfield limestone
Єo
Ophir shale
Єtq
Tintic quartzite
Fault or fissure, showing dip and downthrown side
Vertical fault or fissure
Strike and dip of beds
Horizontal beds
Raise
Winze
Inclined workings
50
0
250 Feet

Figure 195:

GEOLOGIC MAP OF THE YANKEE MINE

Adapted from Calkins and Butler, 1943, plate 51

in the mine.

References:

Calkins, F. C. and B. S. Butler, 1943, Geology and ore deposits of the Cottonwood-American Fork area, Utah: U. S. Geol. Survey Prof. Paper 201, 152p.

James, L. P., 1969, George Tyng's last enterprise: a prominent Texan and a rich mine in Utah: Journal of the West, v. 8, n. 3, p. 429-437.

East Tintic District

The East Tintic mining district is located in the East Tintic Mountains and straddles the Utah-Juab County line 15 miles (24.1km) southwest of Santaquin and 21 miles 33.7 km) northwest of Nephi. The East Tintic district is related to the Tintic mining district in Juab County which lies adjacent and to the west. The district's development lagged behind that of the main Tintic district due to blind ore bodies (not exposed at the surface) and the difficulty in locating them. The first ore was discovered in 1909 when fissure veins were encountered in sinking the Eureka Lilly shaft. The first major ore discovery was made in 1916 by E. J. Raddatz after nine years of shaft sinking and cross-cutting (Bush, 1975, p. 97). This led to the discovery of the Tintic Standard "pothole" ore body which touched off aggressive geological exploration leading to the discovery of the North Lily and Eureka Lilly ore bodies in 1927 and of the Eureka Standard mine in 1928. A few smaller mines were later established but no important discoveries were made for many years leading to a low in activity in the early 1950s. The next boom followed the exploration by Bear Creek Mining Co. in the 1950s leading to the discovery of the Burgin ore body in 1958 and the development of the Trixie ore body in 1969. In 1976 Kennecott Copper Corporation's Tintic Division's Burgin and Trixie mines were the only producing mines in the district. The district is credited with producing 4,940,096 tons of ore containing 522,047 ounces gold, 75,742,573 ounces silver, 28,310,339 pounds copper, 1,025,694,543 pounds lead, and 294,043,133 pounds

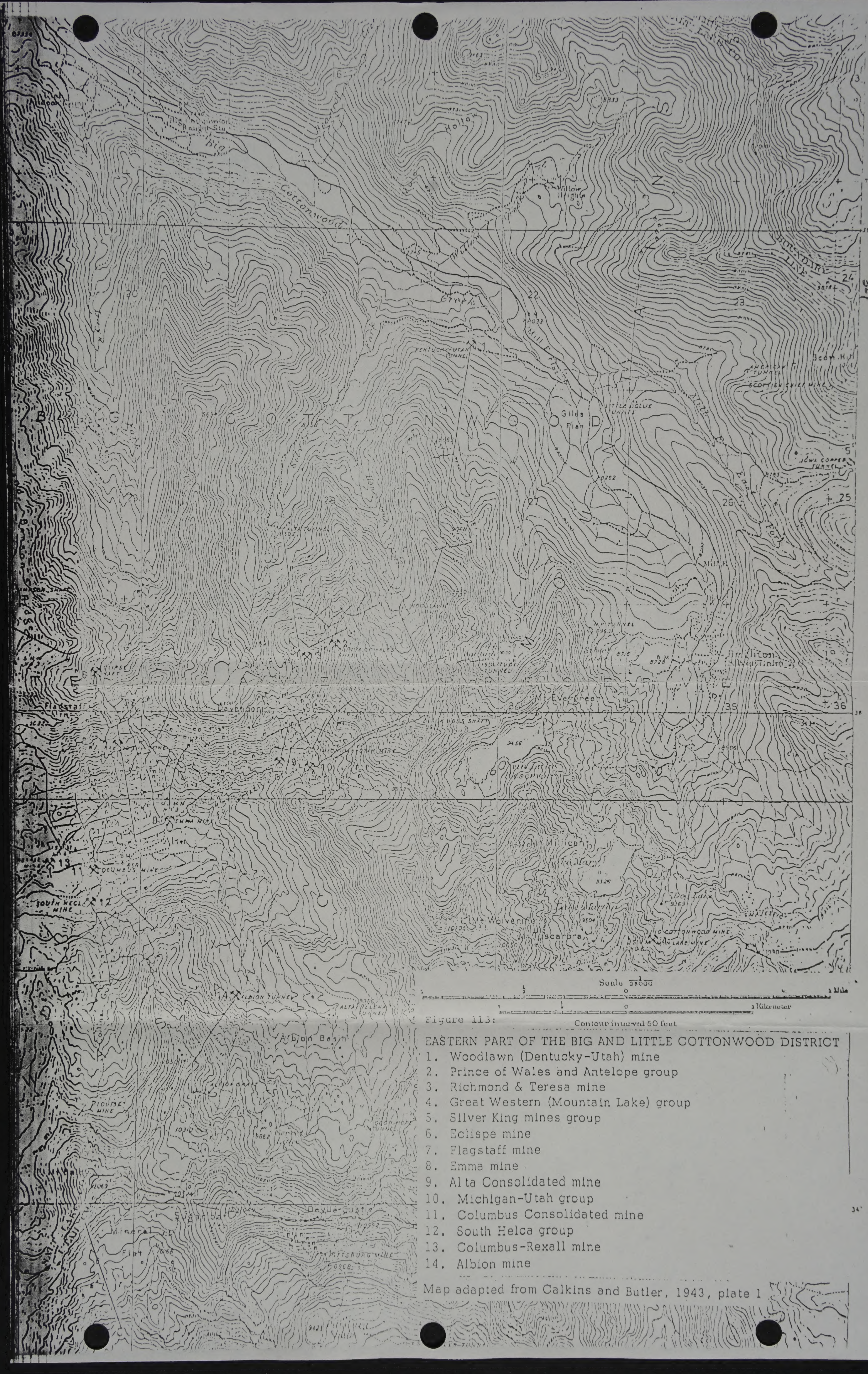


Figure 113:

EASTERN PART OF THE BIG AND LITTLE COTTONWOOD DISTRICT

1. Woodlawn (Dentucky-Utah) mine
2. Prince of Wales and Antelope group
3. Richmond & Teresa mine
4. Great Western (Mountain Lake) group
5. Silver King mines group
6. Eclispe mine
7. Flagstaff mine
8. Emma mine
9. Alta Consolidated mine
10. Michigan-Utah group
11. Columbus Consolidated mine
12. South Helca group
13. Columbus-Rexall mine
14. Albion mine

Map adapted from Calkins and Butler, 1943, plate 1

zinc (table 51).

The geology of the East Tintic district has been summarized by Shepard and others (1969, p. 218-219):

> "The rocks exposed at the surface and penetrated by mine workings and drill holes in the East Tintic district include approximately 10,000 feet of Paleozoic miogeosynclinal deposits and as much as 5,000 feet or more of Middle Eocene latite and quartz latite lavas, tuffs and agglomerates, all of which have been intruded by stocks, plugs, dikes, and sills of monzonite and quartz monzonite porphyry... ...The best known of the stratified rocks are the Ophir Formation and adjacent units, which are the principal host rocks of the major ore bodies and thus are extensively exposed in most of the mines.
>
> The igneous rocks are the deeply eroded remnants of a composite volcano of Middle Eocene age. The core of this volcano, located a few miles southwest of the East Tintic district, was intruded by small stocks of monzonite and quartz monzonite forming the north-northeasterly trending belt of intrusive rocks that cuts the central part of the district."

The East Tintic mining district is noted for its blind and structurally complex ore bodies. The ore bodies fall into two categories; replacements in the limestone beds of the Ophir Formation along thrust faults and as northeasterly trending fissure veins in the Tintic Quartzite. The Tintic Standard "pothole" ore body is an excellent example of the first type and the siliceous ore bodies of the Eureka Standard are examples of the second type. The ore-bearing solutions emanated from monzonite and quartz monzonite melts and migrated up and outward from their sources. These solutions found prepared ground along faults and fractures replacing the carbonate rocks and forming massive replacement ore bodies containing gold, silver, copper, lead, and zinc in large quantities (figures 196 and 197).

The volcanic rocks that cover most of the district make it difficult and expensive to locate ore bodies below them. The district has tremendous potential for lead-zinc ore bodies especially in the Ballpark area northwest of the Burgin and in the South Apex are southeast of the Burgin mine. Little exploration has been done in these areas excepting widely spaced diamond drill holes from the surface. Paul Mogensen, Kennecott's Tintic Division geologist, suggests that 3,300,000 tons of mineralized rock (lead-zinc ore) bearing more than 10 percent

Table 51: Mine production - East Tintic district, Utah, 1909-1975

Mine	Interval	Tons	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Apex Standard[1]	1928-1937	13,728	1,373	188,074	109,074	741,312	--
Burgin[2*]	1963-1975	1,384,655	482	14,090,715	76,756	303,524,472	285,161,083
Eureka Lilly	1909-1952	227,610	53,254	1,227,754	3,747,328	21,750,597	18,950
Eureka Standard	1928-1952	362,375	242,903	3,430,277	2,715,748	11,209,798	3,496,852
Iron King[1]		14,000	1,400	19,601	28,000	--	--
North Lily Group (Includes: North Lily, Baltimore, Tintic Bullion, Eureka Bullion, Hannibal, Provo, and other properties operated through North Lily shaft)	1927-1949	375,000	148,000	3,554,000	2,482,000	101,682,000	4,270,000
Tintic Standard (Includes ore from Harold Mill dump, 1943-1952)	1913-1952	2,469,722	90,005	52,239,832	18,502,917	554,689,732	954,748
Trixie[2*]	1968-1975	89,379	14,148	981,246	579,218	950,583	141,500
20th Century	1943-1947	1,419	40	7,320	59,716	1,338	--
Zuma[1]	1928-1944	2,208	442	3,754	8,832	343,608	--
Totals		4,940,096	552,047	75,742,573	28,310,339	1,025,694,543	294,043,133

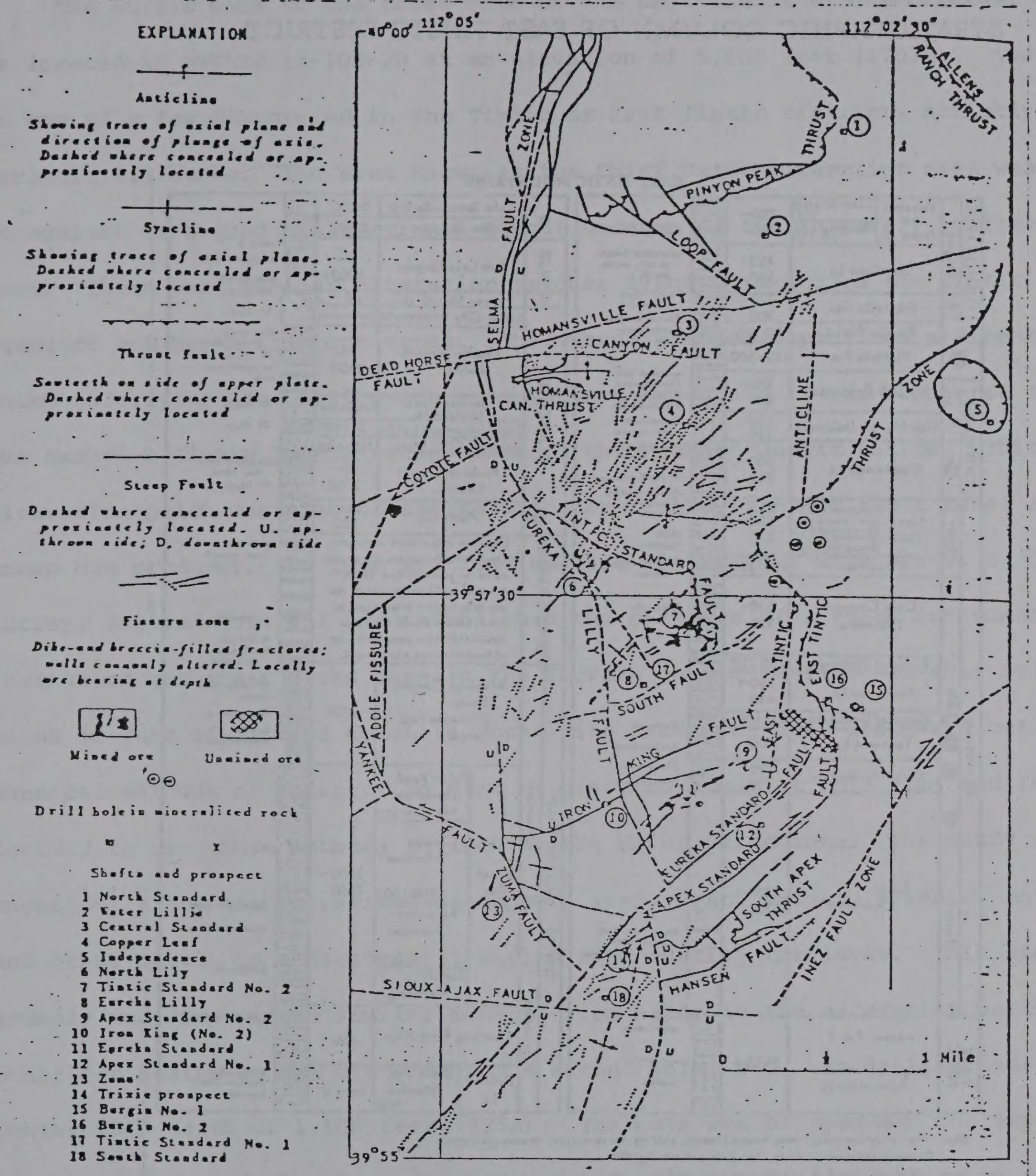
1. Data modified from Cook, D. R., editor, 1957, pl. 3.
2. Morris, H. T., T. S. Lovering and others (in press), Geology of mines of the East Tintic mining district, Utah and Juab Counties, Utah: U. S. Geological Survey Professional Paper 1024.
3. Data modified from Kildale, M. B., in Cook, D. R., 1957, p. 105.

All other data from U. S. Bureau of Mines.

does not reflect recoveries after milling or smelting.

Figure 196:

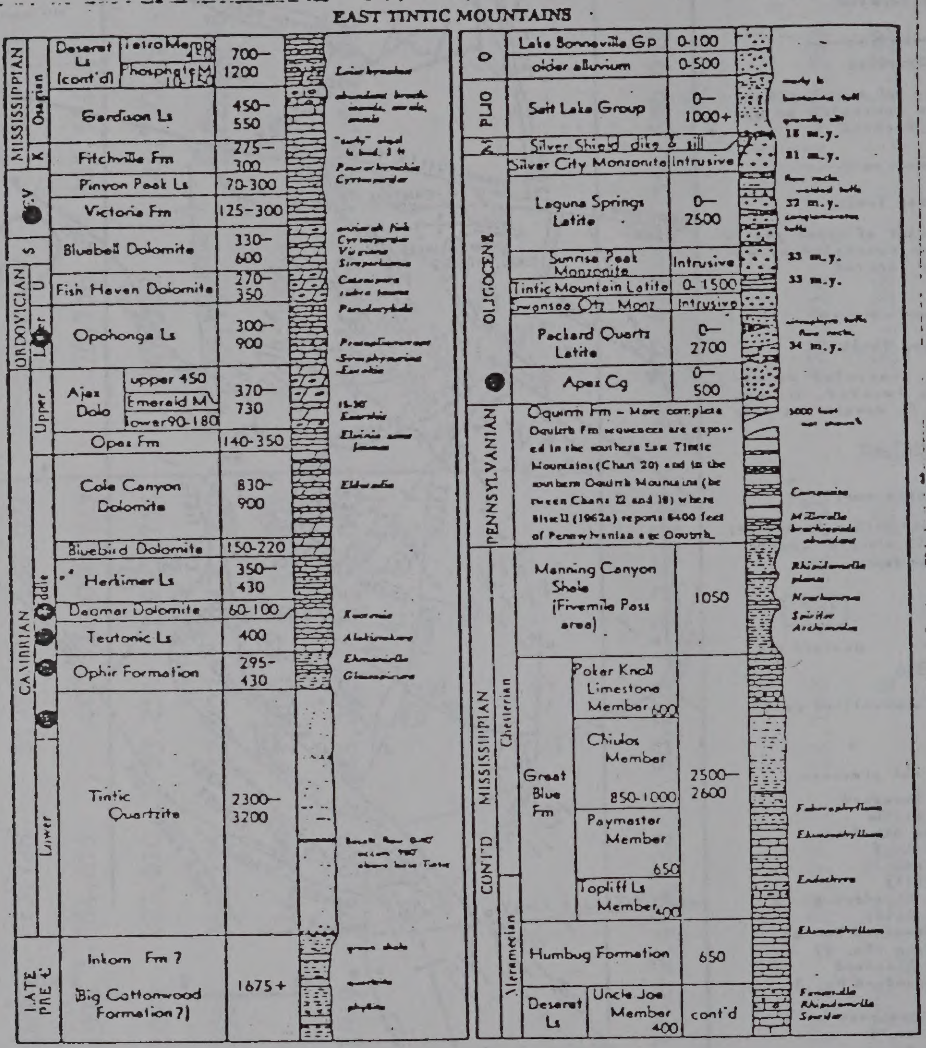
LOCATION AND STRUCTURE MAP OF EAST TINTIC DISTRICT



Subsurface Structure Map of East Tintic District, Utah, showing mined and unmined ore bodies.

Adapted from Shepard, Morris and Cook, 1968, p. 948

Figure 197:
STRATIGRAPHIC COLUMN OF EAST TINTIC DISTRICT



After: Morris and Lovering (1961); Morris (1964a), (1964b); Precambrian: Woodward (1972)
Cenozoic radiometric dates: Laughlin and others (1969)

From Geologic History of Utah by L.F. Hintze, p. 136.

● Ore-bearing horizons

lead might be present in the East Tintic district (James, 1973, p. 35).

Burgin Mine

The Burgin mine is the chief mine of the East Tintic mining district and is located in NWSESE 15-10S-2W at an elevation of 5,600 feet (1707m). The mine is one of a few discovered in the Tintic or East Tintic districts strictly by geologic inference. The area known as the Chief Oxide alteration area was recognized as a good explorational target because of the intensely pyritized lava. There were similar alteration patches lying uprake from the Tintic Standard and North Lily ore zones. The subsurface geology of the sedimentary rocks underlying the Chief oxide area was not known and it was suspected that the Cambrian Tintic Quartzite lay beneath the Packard Quartz Latite. This alteration patch was also on strike with the Eureka Standard fault zone, a known ore producer. In 1946 and 1947 Newmont Mining Co., with the U. S. Geological Survey, drilled hole N-1 and established the presence of a thick but unknown section of carbonate rocks beneath the Packard Quartz Latite. In this hole about 50 feet of altered dolomite containing traces of lead-zinc were cut. Geochemical methods of prospecting were of great interest at this time and it was decided to use these methods to look at the Chief Oxide zone. The study revealed anomalous trace concentrations of copper, lead, zinc, silver, arsenic, antimony and other metals in a northeast trending zone cutting the lavas. This geochemical anomaly was compared to similar mineral-rich halos in the alteration patches of other ore bodies in the district and a second hole, N-2, was drilled near its center to a depth of 1,100 feet (335m). The hole was stopped and the exploration program terminated when no ore was found. Despite Newmont's failure to find ore, the U. S. Geological Survey continued to maintain an interest and additional mapping was done in the alteration area. After careful evaluation, the U. S. Geological Survey decided to deepen N-1 by core drilling, hopefully to provide additional geologic information that might encourage private mining companies to explore the area. The most significant result of this drilling was the discovery of fossil corals and brachiopods of Devonian and Mississippian age. This led to a reanalysis of the sublava structure and sedimentary rocks. The presence of Devonian and Mississippian rocks suggested the existence of a completely concealed north-trending thrust fault that was probably intersected by northeasterly trending mineralized faults and fissures. It was thought that such a structure might lead to a significant ore body as it was the same situation found in the Tintic Standard mine. Deepening of the hole cut low grade ore at a depth of 1,400 feet (427m).

Kennecott Copper Corporation became interested in the area through its explorational company, Bear Creek Mining Co., and began investigations in 1955. The encouraging results of the U. S. Geological Survey work led Bear Creek to begin sinking the Burgin No. 1 shaft in 1956. A limited amount of surface drilling was done prior to this to locate the best shaft site and to obtain additional information concerning the sublava sedimentary rocks. In January, 1957, the Burgin No. 1 shaft was sunk to a depth of 1,100 feet (335m) and by August, 1959, lateral development on the 1050 level totaled 4,721 feet (1439m) and diamond drilling totaled 15,480 feet (4718m). Early in 1958, on the 1050 level, about 1250 feet (381m) west of the Burgin No. 1 shaft, the suspected thrust fault was encountered. This was about 225 feet (69m) below the workings of the 1000 level of the Apex Standard mine driven over this area 20 years previous. Exploration north and south along the fault led to the discovery of high-grade ore and down-dip extensions were confirmed by additional core drilling. At the time the mine was opened a minimum of 1,250,000 tons of ore containing 10 ounces silver, 15 percent lead, and 12 percent zinc had been established through drilling and drifting (Morris, 1964, p. 291-293). After the ore body had been proven it was decided to sink a second shaft for production purposes. It was sunk and the 1050, 1200 and 1300 levels were established, the latter 1265 feet (386m) below the shaft collar.

Production in the Burgin mine started in 1966 and has been continuous to

the present (1976). Burgin mine production to the end of 1975 was 1,384,655 short tons of ore yielding 482 ounces gold, 14,090,715 ounces silver, 76,756 pounds of copper, 303,524,472 pounds lead and 28,161,083 pounds of zinc. The figures represent total metal content of the ore and do not represent recovery after concentration or quantities paid by custom mills. The ore bodies of the Burgin mine consist of various proportions of sphalerite, argentiferous galena and pyrite in a gangue of rhodochrosite, and baritic jasperoid. The highest grade ore is massive sulfide composed predominantly of galena or sphalerite with minor pyrite. Intermediate ore contains various amounts of sphalerite and galena and minor pyrite in vuggy rhodochrosite and scattered irregular masses of jasperoid. Minerals found in the Burgin mine are galena, sphalerite, cerussite, anglesite, massicot, minium, pyromorphite, tetrahedrite, argentite, manganosiderite, plumbojarosite, wad and chalcophanite. Gangue minerals are barite, quartz, rhodochrosite, pyrite, dickite, kaolinite, jasperoid, and jarosite.

The geology of the Burgin mine is complex. The footwall of the East Tintic thrust is composed of Ordovician to Devonian age rocks. The hanging wall is Cambrian Tintic Quartzite and Ophir Shale. The main Burgin ore body occurs along the fault where the Ophir Shale has been thrust over the Ordovician Opohonga Limestone. Other ore bodies are in the footwall and are similar to those found in the main Tintic district. The reserves in the Burgin mine are kept confidential by Kennecott Copper Corp. but it is safe to estimate that a quarter million tons remain below the 1300 foot level in the main ore body. This ore will have a grade of at least 30 percent lead and zinc and 15 ounces silver to the ton. Unknown quantities of ore remain in the "274" ore body which lies in the footwall of the East Tintic thrust. The Ball Park area of the Burgin mine probably contains the largest amount of low-grade lead-zinc ore known in the state of Utah. This ore will range from less than 1 percent combined lead-zinc to a high of 20 percent. Future exploration will probably prove the presence of ore bodies amounting to several million tons. One of the unusual things about the Burgin ore body is its relationship with manganese oxides, not found in other mines of the area. Manganese oxides occur at the Tintic Standard and Iron King mines but are not closely related to the silver-lead-zinc mineralization as they are in the Burgin. Large masses of manganese-iron oxides encase the lead-carbonate ore bodies in the oxidized zones and rhodochrosite and manganosiderite are found below. This is especially true on the east end of the main Brgin ore body (Bush and Cook, 1960).

Trixie Mine

The Trixie mine is located about 2 miles (3.2 km) south of the Burgin mine in SWNENE 28-10S-2W at an elevation of 6,050 feet (1844m). Interest to explore the Trixie area started at about the same time as did the interest in the Chief Oxide alteration area. Bear Creek Mining Co. projected an eastern extension of the Sioux-Ajax fault, which crosses the main Tintic district and into the East Tintic district and traced as far as the Crown Point mine. Anomalous lead-zinc values and in one instance some high-grade lead-zinc-silver ore were discovered by drilling the supposed extension. This led to the sinking of a two-compartment shaft to the 750 level in 1968. Northward drifting on this level encountered the Trixie fault and examined lead-zinc mineralization discovered by a surface drill-hole. Diamond drilling from the shaft station of the 750 level revealed the existence of a previously unknown fissure vein in the quartzite. The fissure strikes north-south and dips 65 degrees to the west and has a strike length of about 1,000 feet. A drift was cut along this fissure and raises were run to a sublevel established from the shaft at 625 feet (191m). Further sinking of the Trixie shaft extended below the 1050 level. Exploration looking for the Sioux-Ajax fault has been done southward on the 750-foot level. A high-grade gold and silver ore body was encountered in this area and is presently being mined. Through 1975 the mine has produced 89,379 tons of ore containing 14,148 ounces of gold, 981,246 ounces silver, 579,218 pounds copper, 950,583 pounds lead and 141,500 pounds zinc. Mine workings in the Trixie consist of four levels, at 625, 750, 900 and 1050 feet (191, 229, 274 and 320m). The most extensive level is the 750. Total workings in the Trixie consist of a mile of drifts, crosscuts, raises and winzes.

The ore deposits are of two types: lead-zinc-copper replacement ore along the Trixie fault and fissure vein deposits in the Tintic Quartzite. The Trixie fault ore are replacements of Ophir Shale limestone units. Primary minerals include chalcopyrite, bornite, luzonite, tennantite, tetrahedrite, digenite, galena, sphalerite, stromeyerite, native gold and pyrite. Secondary minerals are chalcocite, covellite, bournonite, azurite, malachite, aurichalcite, olivenite, chrysocolla, cerussite, plumbojarosite, mimetite, anglesite, argentite, argentojarosite, bindheimite, jarosite, hematite and scorodite (Pope, 1971, p. 141-142). At present mining is taking place in the vein-type ore deposits and ore is being shipped as flux to Kennecott's smelter at Magna. Reserves of the Trixie mine are held confidential by the company but it seems assured that remaining reserves are adequate to maintain the present productive level for a considerable number of years. There are several excellent explorational targets remaining near the mine that should enlarge the resource.

Tintic Standard Mine

The Tintic Standard No. 2 shaft is located 2.75 miles (4.4 km) east of Eureka and is accessible from the road leaving east of the summit to Dividend. The No. 2 shaft is just above the Dividend townsite in SWSWNW 15-10S-2W at an elevation of 5,975 feet (1821m). Mine workings consist of 3 shafts and associated lateral workings. There are 230,000 feet (70,104m) lateral workings, 30,000 feet (9144m) of raises and winzes and the shafts are 1,494 feet, 1,557 feet and 600 feet (455, 475, and 182m) deep.

The ore bodies are found as replacements in the Ophir Limestone along the Tintic Standard thrust fault and are found in fissure and breccia zones in the Tintic Quartzite. The replacement ore bodies are largely oxidized and contain cerussite, smithsonite, anglesite, cerargyrite, argentojarosite, galena, tetrahedrite, argentite, native silver, enargite, malachite, azurite and covellite. Gangue minerals are quartz, barite, calcite, dolomite, pyrite and jasperoid. Production from the mine is 2,372,148 tons of ore averaging a trace of gold, 24.4 ounces silver, 11.9 percent lead, 0.4 percent copper, and a trace of zinc. Reserves consist of a shaft pillar at the No. 2 shaft from 1,174 to 1,365 feet (358-416m). This pillar contains 80,000 tons of ore averaging 20 ounces silver and 10 percent lead. The ground is heavy and would be difficult to mine safely.

North Lily Mine

The North Lily mine is located about 2 1/4 miles (3.6 km) east of Eureka in NESENW 16-10S-2W at an elevation of 6,275 feet (1913m). Mine workings consist of a shaft 1,850 feet (564m) deep with levels at 700, 900, 1,000, 1,200, 1,350 and 1,500 feet (213, 274, 305, 366, 411 and 457m) along with several sublevels. The workings have a combined length of about 10 miles (16 km). The shaft is collared in Packard Quartz Latite and Cambrian limestone is cut at 475 feet (145m) and the Tintic Quartzite is cut at a depth of 1,605 feet (489m). At least two thrust faults are encountered in the shaft. Ore bodies are in the middle of the Ophir Limestone where it is in thrust contact with the Tintic Quartzite and in breccia zones in quartzite. The mine has produced 377,500 tons of ore from 5 different claims and 271, 603 tons averaged 0.2 ounces gold, 10.4 ounces silver, negligible copper, 17.7 percent lead, and 0.5 percent zinc. The replacements are lead-zinc-silver ore and the fissures contain gold-copper-silver ore. Some of the fissures contained very high grade gold and cut samples of over 2,000 ounces per ton came from the Endline dike fissure. Ore minerals in the North Lily are enargite, tetrahedrite, hessite, petzite, pearceite, galena, sphalerite, cerussite, smithsonite, cerargyrite, argentojarosite, native silver, native gold, chalcopyrite, anglesite, tennantite, bismuthinite and plybasite. Gangue minerals are pyrite, barite, quartz, jasperoid, calcite and dickite.

Eureka Lilly Mine

The Eureka Lilly mine is 2.5 miles (6.3km) east of Eureka on the road extending from east of the Eureka Summit to Dividend. The shaft is on the east side of the road between the Tintic Standard No. 1 shaft and the North Lily shaft in SENWSE 16-10S-2W at an elevation of 6,100 feet (1859m). The mine workings consist of a shaft 1,587 feet (484m) deep. There are 8 levels and an inclined winze extending from the 500 to 1,400 level from which several intermediate levels have been driven. The workings have a total length of about 15,000 feet (4572m). The mine is credited with the production of 245,000 tons of ore averaging 0.25 ounces gold, 5.6 ounces silver, 3.6 percent lead and 0.8 percent copper.

The ore bodies are replacement lead-zinc-copper ores in the Ophir, Dagmar and Teutonic Limestones. Fissure ore bodies are in the Tintic Quartzite, particularly along the South fault. The replacement ores are chiefly oxidized lead and zinc minerals with accessory silver and copper minerals. Fissure ores contain enargite, tetrahedrite, and gold tellurides in a gangue of barite, quartz, pyrite, calcite and dolomite. Reserves are small and the claims have been adequately explored in the vicinity of the South fault above the Tintic Quartzite.

Eureka Bullion Mine

The Eureka Bullion shaft collar is about 2 1/2 miles (4km) east of Eureka in NENESW 16-10S-2W at 6,225 feet (1898m) in elevation. Mine workings consist of a shaft 632 feet (193m) deep which connects with the 800 level of the Eureka Lilly mine. A winze from this level connects with the 1,150-foot level. There are 14,116 feet (4,303m) of lateral workings in the mine. The shaft is collared in the Cole Canyon Dolomite and ends in the Herkimer Limestone. The lowest workings are in the Teutonic Limestone. Fissure ore deposits were mined that extend into the North Lily and Tintic Bullion properties.

Replacement ore bodies were explored near the deep winze near the shaft. All workings are in the hanging wall of the Eureka Lilly fault. Fissure ores contain enargite, argentite and much pyrite. Replacement ores contain oxidized lead and zinc minerals and some cerargyrite. The mine is credited with a production of 18,589 tons of ore averaging 0.13 ounces gold, 8.19 ounces silver, 1.8 percent copper and 0.2 percent lead. Reserves in the mine are unknown, but are believed to be small.

Provo Mine

The Provo shaft is 2.5 miles (6.3km) east of Eureka on the east side of the road that leads to Dividend. The shaft collar is 300 feet (91m) north of the Eureka Lilly shaft and is in SENWSE 16-10S-2W at an elevation of 6,150 feet (1875m). The mine workings consist of the shaft, 300 feet (91m) deep and 700 feet (213m) of lateral workings on the 300-foot level. The shaft is collared in Herkimer Limestone and bottoms in the Teutonic Limestone. The ore bodies are fissure-like replacements followed into the property from the Eureka-Lilly mine. Ore consists of cerussite, cerargyrite, malachite, and smithsonite in a gangue of barite and brecciated dolomite. Production was about 150 tons of ore, the grade of which is unknown. No reserves remain in the mine.

Eureka Standard Mine

The Eureka Standard mine is 1 mile (1.6km) southwest of the Burgin mine, the shaft collar is in SESWNW 22-10S-2W at an elevation of 5,860 feet (1786m). The mine workings consist of two shafts; the Montana shaft 500 feet (152m) deep and the Eureka Standard shaft 1,424 feet (434m) deep. The lateral workings have a length of 52,000 feet (1545m) and raises and winzes equal 10,000 feet (3048m) for a total of 64,000 feet (19,507m) of workings in the mine. The Eureka Standard shaft is collared in Packard Quartz Latite and cuts Cambrian limestone at 600 feet (183m), it crosses the Eureka Standard fault at 900 feet (274m) and enters the Tintic Quartzite and remains in it to the bottom.

The ore bodies are in narrow fissures and breccia zones in the footwall of the Eureka Standard fault. Minor replacement ore bodies were mined in the Ophir Formation in the hanging wall block of the Eureka Standard fault. The ore minerals in the fissures are gold tellurides, enargite, tetrahedrite, galena, and sphalerite. Replacement ores contain galena, sphalerite and their oxidation products. Gangue minerals for both ore body types are pyrite, barite and quartz. The mine is credited with the production of 362,832 tons of ore averaging 0.7 ounces gold, 9.27 ounces silver, 1.02 percent lead and 0.37 percent copper. Mining of the fissure ores was stopped because of hot underground water. The potential for replacement ore is small and the mining of the deeper fissures will require extensive pumping. At present the dump is being shipped by Kennecott Copper Corp. for flux to their Magna smelter.

Apex Standard Mine

The Apex Standard mine is located 1 mile (1.6km) southwest of the Burgin mine and is accessible from the Silver Pass road. The Apex No. 1 shaft collar is in SESENW 22-10S-2W at an elevation of 5,825 feet (1775m). Mine workings consist of two shafts, the Apex No. 1 and the Apex No. 2, 897 feet (273m) and 1,552 (473m) feet deep, respectively. There are 6 levels between the shafts, not all connect with both. Several thousand feet of lateral workings are in the mine as well as several long raises and winzes. Total workings are about 30,000 feet (9,144m) in length. The mine is credited with the production of 13,728 tons of ore averaging 0.01 ounces gold, 13.7 ounces silver, 2.7 percent lead and 0.4 percent copper. The ore bodies are tabular breccia zones and fissures in the Tintic Quartzite near the Eureka Standard and Middle faults. The minerals in the siliceous ore are enargite, tetrahedrite, galena, gold and silver tellurides and native gold. Gangue minerals are barite and quartz. Reserves are nil in the developed parts of the mine. There are good prospects in the southern part of the property which have not been adequately explored.

Surface alteration suggests the possible presence of a large ore body.

Iron King Mine

The Iron King mine is located on the north side of Burriston Canyon 1500 feet (457m) southwest of Mineral Hill. The Iron King No. 1 shaft is in NWSENW 21-10S-2W at an elevation of 6,285 feet (1916m). The Iron King mine was worked in the early 1920s and possibly in the 1930s. It was mined for siliceous copper-gold-iron ores uses as smelter flux. It produced 14,001 tons of siliceous baritic copper-gold ore averaging 0.1 ounces gold, 1.4 ounces silver, and 0.1 percent copper. In all 50,000-100,000 tons of iron flux was shipped from the mine. The mine workings consist of three shafts, 500, 1,545, and 1,544 feet (152, 471, and 471m) deep from which several levels were run. There is also a long adit and several short adits on the property and total workings have a length of 2 miles (3.6km). Minerals found in the ore are enargite, galena, tetrahedrite, argentite, hessite, native gold, pyrite, barite, quartz, limonite and hematite. Ore bodies occur in the quartzite and in shale breccia along the Eureka Standard fault near the No. 2 shaft. Iron ore bodies are near the No. 1 shaft and consist of limonite and hematite replacing the base of the Packard Quartz Latite. Reserves in the mine are small to negligible.

Zuma Mine

The Zuma mine is located on the south side of Burriston Canyon about 1 mile (1.6km) west of the Burriston Canyon and Silver Pass road junction. The shaft collar is in NESWSW 21-10S-2W at an elevation of 6,225 feet (1897m). The mine workings consist of a shaft 1,200 feet (366m) deep from which levels are turned at 200, 500, 800 and 1,200 feet (61, 152, 244, and 366m). All the levels extend to the south of the shaft.

The ore bodies are found in the Opohonga Limestone near its contact with porphyry. Minerals are argentite, galena, barite, quartz, and pyrite. Silver was the principal metal produced, but lead, copper, and gold were important byproducts. The Zuma is credited with 2,208 tons of ore averaging 0.2 ounces gold, 1.7 ounces silver, 0.2 percent copper and 7.8 percent lead. This is probably not a complete record of production from the mine. There are no known reserves in the mine.

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WASHINGTON COUNTY

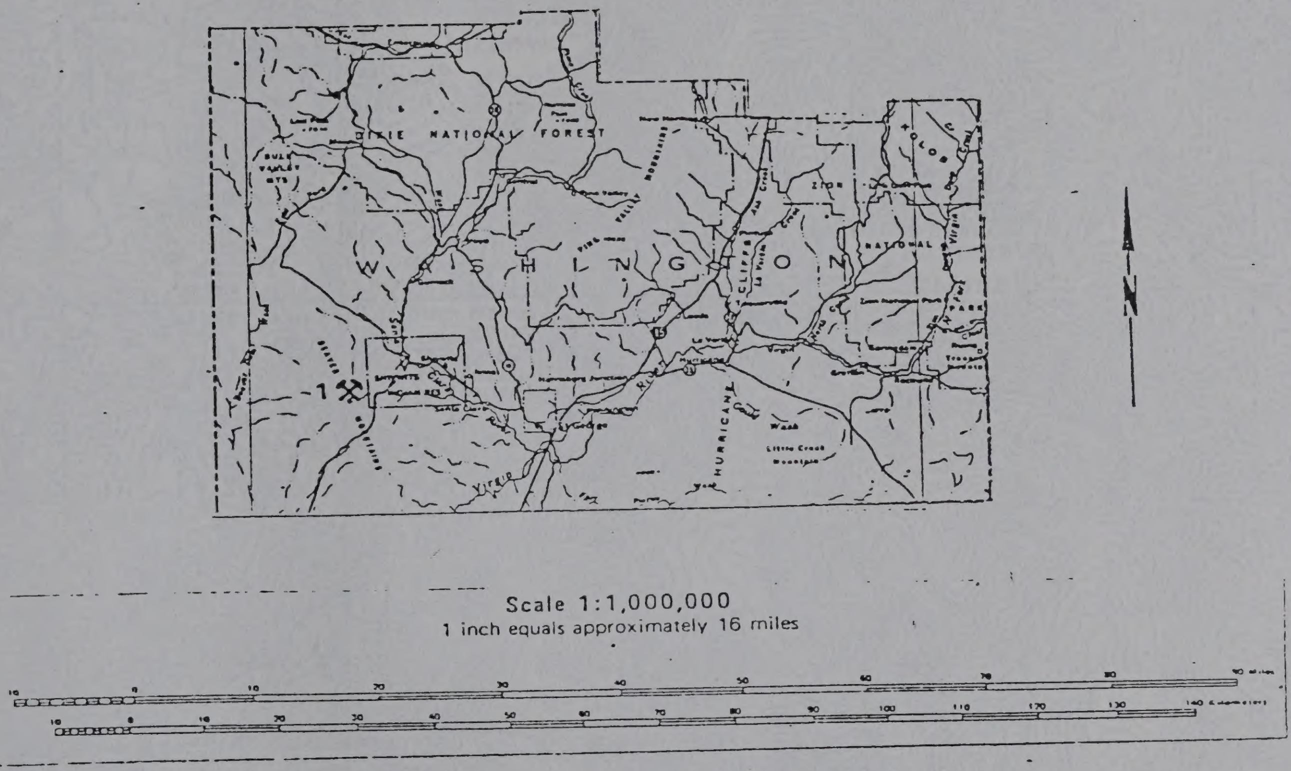
A small amount of lead and zinc were produced in Washington County in a mining history that extends from 1869 to 1968. Presently there are no active mines producing the two commodities, which were produced together with gold, silver, copper, and uranium. The total county production of lead amounts to 695 tons and that for zinc amounts to 12 tons. The value of the lead is set at $159,617 and the value of the zinc is set at $3,260 (table 52). Lead and zinc have been produced in two districts; Harrisburg-Silver Reef and Tutsagubet. Most of the production came from the Tutsagubet mining district which has the greatest potential for future production. Washington County is located in the southwestern corner of the state and the Tutsagubet mining district is located in the southwestern part of the county (figure 198).

Tutsagubet District

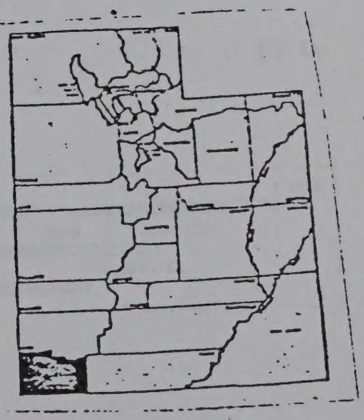
The Tutsagubet district is in the central part of the Beaver Dam Mountains about 14 miles (22.5km) west of St. George. The district straddles the Beaver Dam Mountain divide and lead-zinc ores have been mined from both sides (figure 199). The mining district was organized on June 2, 1883, but locations had been made in the area as early as 1871. In 1884 the Mountain Chief Mining Co. built a one-stack furnace on the Virgin River to reduce the lead carbonate ores; smelting began in November, 1884, but in September, 1885 operations ceased because of litigation (Butler and others, 1920, p. 596). The amount of bullion produced by the furnace is unknown and recorded as a query in the county production figures (table 52). Between 1884 and 1888 the Apex mine was worked producing and shipping 300 tons of copper ore and from 1889 to 1893 the mine received $300,000 for copper ore and bullion containing lead values which were shipped to Swansea, Wales and Denver, Colorado. The district has been worked intermittently producing copper and lead ore when the market was favorable through 1962. There has been no production from the district in recent years. The available production records for the district

Figure 198:

WASHINGTON COUNTY



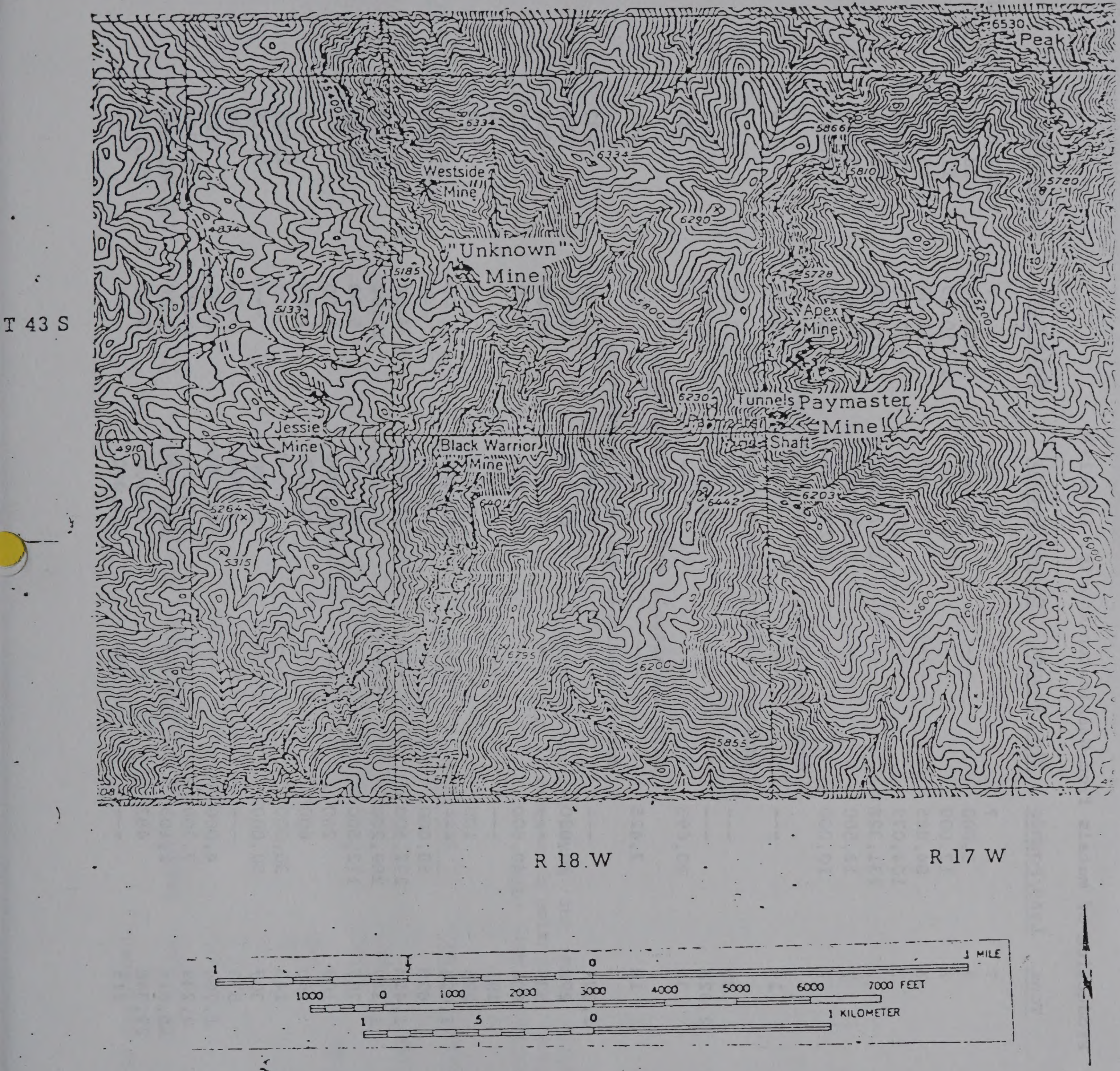
1. Tutsagubet district



Location map for Washington County and the Tutsagubet mining district.

Figure 199:

LOCATION MAP OF THE TUTSAGUBET MINING DISTRICT



Adapted from USGS Beaver Dam SE 7 1/2' quadrangle

Table 52: Production of metals from Washington County, 1869-1976

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1869-1902	?	?	---	3,783,306	?	7,302,885	$8,531,946+
1903	?	3,000	---	750,000	1,700.00	18,000	143,040
1904	?	17,000	---	870,000	1,250.00	11,000	146,300
1905	?	84,885	---	117,287	191.00	10,200	33,141
1906	?	104,079	---	225,000	607.73	3,008	63,773
1907	?	231,328	---	1,275,000	743.18	3,169	284,233
1908	?	12,500	---	1,145,000	74.89	3,885	167,960
1909	?	10,000	---	2,236,738	112.70	3,504	295,365
1910-1911			data unavailable and/or no production				
1912	18	---	---	---	9.39	4	196
1913			data unavailable and/or no production				
1914	35	---	---	---	23.22	9	485
1915-1922	2,028	---	---	802,343	621.15	2,289	199,266
1923	36	20,693	---	---	1.11	637	1,994
1924			data unavailable and/or no production				
1925	18	7,425	---	1,440	0.19	164	969
1926-1927			data unavailable and/or no production				
1928-1936	2,371	---	---	1,374,387	128.86	232	151,987
1937	278	20,000	---	63,909	4.00	618	9,531
1938-1941	239	---	---	86,003	28.00	394	9,875
1942	636	40,600	---	190,000	7.00	1,585	27,082
1943	191	---	---	72,400	1.00	90	9,511
1944	596	100	---	233,000	2.00	90	31,597
1945	2,025	---	---	791,400	1.00	235	107,034
1946	838	68,000	---	177,500	---	2,693	38,343
1947	1,414	272,500	---	160,900	4.00	10,052	82,266
1948	1,247	289,200	---	63,500	10.00	12,323	77,049
1949	707	112,500	---	21,900	5.00	6,270	28,165
1950	109	200	---	43,900	1.00	85	9,270
1951	163	600	---	41,800	1.00	411	10,627
1952	143	30,000	---	---	---	1,085	5,812
1953	307	50,000	2,000	30,000	---	2,476	17,631
1954	533	---	---	166,000	5.00	232	49,355
1955	1,764	4,000	---	346,000	10.00	597	130,544
1956	2,239	7,000	---	221,600	11.00	11,744	106,293
1957	15,614	2,100	16,700	201,300	8.00	73,271	129,422
1958	22,348	483	---	54,000	22.00	56,145	65,897
1959	215	---	209	68,000	---	---	20,988

Table 52 continued:

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
1960	579	191	2,000	144,000	---	5	$46,704
1961	4,950	472	1,000	154,000	---	469	46,566
1962	37	---	100	12,000	---	92	3,654
1963	339	183	291	4,000	---	5,889	8,791
1964	2,545	---	2,000	18,000	---	3,750	11,048
1965-1966				no production			
1967	1,500	---	---	2,000	---	3,680	6,316
1968	5,000	---	---	4,000	1.00	9,351	22,000
1969-1976				no production			
Totals:	71,062+	1,389,039+	24,300	15,602,613	5,584.42+	7,562,668	$11,132,026+

1869-1902: Butler, 1920
1903-1909: Estimated by authors
1910-1968: U. S. Bur. Mines Mineral Yearbooks

is summarized in table 53.

Ores in the district are associated with northwest-trending faults and fissures along which replacement deposits have formed in Mississippian limestones. The district has potential of containing additional small tonnage lead-zinc ore bodies. Exploration in the district should be concentrated along the known ore-bearing trends and at greater depths.

Apex Mine

The Apex mine has been known by several names, a few of which are the Pen, Dixie, Dixie-Apex, and Utah-Eastern mine. The Apex mine is in NESWSW 6-43S-17W at an elevation of 5,520 feet (1682m). Initial production from the Apex mine was from 1884 to 1888 when 300 tons of copper ore were shipped. From 1889-1893 the company operating the Apex received about $300,000 for ore and bullion produced. Early production was freighted by wagons 154 miles (247.7 km) to Milford, the nearest railhead. In 1899 a small furnace at St. George produced 8-20 tons of blister copper per month from Apex ore. In 1900 another and larger furnace was erected at Shem, 12 miles (19.3 km) north of St. George, which produced 3-4 tons of bullion daily. The furnace operated until 1907 under several managements (Butler and others, 1920, p. 596). The mine has been worked on a limited and intermittent scale producing small tonnages of high grade copper ore. Coastal Mining Co. maintains the assessment work on the property. Mine workings consist of several adits and an internal shaft at least 900 feet (274m) deep. Total workings exceed 10,000 feet (3048m).

Ore bodies are associated with a fissure striking northeasterly and dipping 45 degrees to the southwest in Callville Limestone. At depth the ore occurs as an irregular chimney. The ore has been oxidized in all of the mine openings and workings and no sulfides have been found. Minerals in the mine include azurite, malachite, native copper, cerussite, hydrozincite, plumbojarosite, smithsonite, cuprite, aurichalcite, adamite, jarosite, limonite and rosasite (Bullock, 1967, p. 75-76). The mine probably contains a small reserve of high-

Table 53: Metals production in Tutsagubet mining district, prior to 1887 to 1976

Years	Tons	Lead/Pounds	Zinc/Pounds	Copper/Pounds	Gold/Ozs.	Silver/Ozs.	Value
Prior to 1887	?	?	---	300,000	1.35	1,200	$42,576
1888-1889				no production			
1890-1894	?	---	---	1,784,065	---	18,562	225,392
1895-1897				no production			
1898-1909	?	43,669	---	8,318,266	---	124,426	1,310,648
1910-1913				no production			
1914-1917	?	---	---	192,735	0.18	667	48,932
1918-1931*	?	28,118	---	1,870,922	?	?	235,980
1932-1940*	522	---	---	250,001	0.60	645	24,135
1941				no production			
1942	626	40,600	---	190,000	1.00	1,585	26,812
1943	191	---	---	72,400	1.00	90	9,511
1944	596	100	---	233,000	2.00	90	31,597
1945	2,025	---	---	791,400	1.00	235	107,034
1946	838	68,000	---	177,500	---	2,693	38,343
1947	1,414	272,500	---	160,900	4.00	10,052	82,266
1948	1,247	289,200	---	63,500	10.00	12,323	77,049
1949	467	112,500	---	10,900	3.00	4,192	23,821
1950	109	200	---	43,900	1.00	85	9,270
1951	111	600	---	39,800	---	42	9,774
1952	143	30,000	---	---	---	1,085	5,812
1953	307	50,000	2,000	30,000	---	2,476	17,631
1954	533	---	---	166,000	5.00	232	49,355
1955	1,756	4,000	---	345,600	10.00	588	130,387
1956	1,533	7,000	---	218,000	7.00	487	94,435
1957	1,012	2,100	16,700	173,800	5.00	338	55,032
1958	?	483	---	54,000	?	?	?
1959	215	---	209	68,000	---	---	20,988
1960	579	191	2,000	144,000	---	5	46,704
1961	4,950	472	1,000	154,000	---	469	46,566
1962	37	---	100	12,000	---	92	3,654
1963-1976				no production			
Totals	19,211+	949,733	22,009	15,864,689	52.13	182,659	$2.773,704

Prior to 1887 to 1917: Butler, 1920
1918-1962: U. S. Bur. Mines Mineral Yearbooks
Years marked with asterisk (*) have years in which no production was achieved.

grade copper ore and a large tonnage of low grade mineralized rock.

Black Warrior Mine

The Black Warrior mine is located on the west side of the Beaver Dam Mountains, over the summit from the Apex mine. The mine is in SENWNW 12-43S-18W at an elevation of 5,600 feet (1707m). The mineralization was discovered at about the same time as that of the Apex mine and moderate amounts of high-grade lead-silver ore have been mined. Mineralization is associated with extensive caves in limestones which dip gently downward from the surface. At the time of discovery a 200-foot long cave was thickly studded with stalagmites, stalactites and columns of calcite and the floor was littered with fallen blocks of limestone. Silver-bearing ore was found in fissures in the sides and top of the cave and beneath the blocks of limestone. Abundant limonite accompanied the cerussite ore; little development has been done outside the actual cave. A few tons of low-grade lead-silver-zinc mineralization remain in the mine workings.

Jessie Mine

The Jessie mine is in NWSESE 1-43S-18W at an elevation of 5,040 feet (1536m). Mine workings consist of an adit, a shaft and two inclines. All of the openings are shallow and are alined along a fault or fissure striking N. 45° E. and dipping 40-50 degrees to the northwest. Mineralization occurs as a replacement of the Mississippian Redwall Limestone. Ore minerals are malachite, azurite, and cerussite in a gangue of limonite and manganese oxides. The copper carbonates occur as rims to the mineralization and limonite, cerussite and manganese oxides make up the centers . The mineralized zone ranges in width from 2 inches to 3 feet (5cm-0.9m) and was followed to a depth of 50 feet (15m). There are no reserves remaining in the mine.

Paymaster Mine

The Paymaster mine is in the first draw south of the Apex mine in SWSWSW 6-43S-17W at an elevation of 5,640 feet (1719m). The mineralization associated with the Paymaster was discovered at the same time as that of the Apex mine. No important orebodies have been found , but small amounts of lead-silver ore have been mined. Mine workings consist of a vertical shaft and several hundred feet of drifting and stoping along a northwest-trending fissure. Minerals in the mine consist of cerussite, jarosite, malachite, azurite, plumbojarosite, limonite and hematite. The mineralized fissure is about 3 feet (0.9m) wide at the surface. No reserves are known to remain in the mine.

Unknown Mine

A mine, the name of which is unknown, is located between the Westside and Black Warrior mines in SWNWSW 1-43S-18W at an elevation of 5,360 feet (1634m). Mine workings consist of a shaft 30 feet (9m) deep along a fissure striking N. 10° W. and dipping 45 degrees southwest and an adit driven beneath it. There are 200 feet (61m) of workings on the adit level. Minerals observed in the mine are malachite, cerussite, limonite and manganese oxides. Malachite occurs along the edges of the mineralized fissure and the cerussite, limonite and manganese oxides occur in the middle. Mineralization occurs in the Mississippian Redwall Limestone. There are no reserves in the mine.

Westside Mine

The Westside mine is located on the west slope of the Beaver Dam Mountains in NWSWNW 1-43S-18W at an elevation of 5,600 feet (1707m). Mine workings consist of an upper and lower adit. The upper adit, the most extensive, consists of 1000 feet (305m) of drifting and crosscutting. The mine workings are in the Mississippian Redwall Limestone and are driven along a fissure striking N. 70° E. containing minor amounts of cerussite and limonite. Total workings are about 1,300 feet (396m) and a small amount of ore may have been mined from them. There are no reserves remaining in the mine.

References:

Bullock, K. C., 1967, Minerals of Utah: Utah Geol. and Mineral Survey Bull. 76, 237

Butler, B. S. and others, 1920, The ore deposits of Utah: U. S. Geol. Survey Prof. Paper 111, 672 p.

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